

ANNALS OF SURGERY

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ORIGINAL MEMOIRS.

THE CONTROL OF BLEEDING IN OPERATIONS FOR BRAIN TUMORS.*

WITH THE DESCRIPTION OF SILVER "CLIPS" FOR THE OCCLUSION OF VESSELS
INACCESSIBLE TO THE LIGATURE.

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ALL surgeons who make for themselves opportunities to observe the manipulative work of their fellows must appreciate the present general tendency toward the abandonment of the applauded methods of comparatively few years ago. The conditions under which Cooper, Pott, and Abernethy worked have long since changed, and though the by-the-clock methods which were essential to operative success in their day are still emulated in some of our present clinics, the stirring, slap-dash, and spectacular is rapidly giving way to the quiet, patient, and undramatic performance.

The elimination of pain has made hurry unnecessary; due respect for the principles which have grown from Listerism has made it inadvisable; the emphasis laid by Halsted on detailed blood-stilling during major operations has proved a further check, and lastly, an expectation of the reactionless healing which occurs only in tissues handled with the greatest delicacy and coapted with scrupulous care is prohibitive of

* Read by title before the American Surgical Association, June, 1911.

haste and the old-time thrills for the bystander which accompanied it.

There are special reasons why the utmost precaution in anæsthetization, the gentlest methods of handling tissues, and the most accurate closure of wounds, accompanied by as pain-taking hæmostasis as possible, should be observed during the more difficult intracranial procedures. Neighborhood oozing obscures the clear view essential to the safety of such delicate manipulations as are required for the removal of, let us say, a lateral recess tumor or the trigeminal ganglion; whereas a more general loss of blood with the consequent lowering of arterial tension is a cordial invitation to its near relative shock, favors the onset of respiratory paralysis in cases associated with medullary pressure, makes anæsthesia more dangerous, and lowers resistance to infection through secondary anæmia.

These are premises, I am aware, which are not accepted by all surgeons, for many still feel that high-gearred methods of operating can outdistance these largely imaginary risks, and there is a wide-spread apprehension lest observation of these minutiae engender a reputation of being a slow and fussy surgeon. For, after all, what do these details amount to, with another patient awaiting his turn and an assistant who can close the wound, put on the dressing, and administer stimulants and infusions. But for those who grant the premises and agree that every effort should be made, even at the expense of time, to respect the tissues and to minimize the loss of blood by whatsoever methods one can summon to his aid, there are certain "tricks" which may be found useful, particularly in cerebral surgery.

It is necessary to bear in mind that two fairly distinct vascular systems will be encountered—internal and external. On the arterial or carotid side these systems are quite distinct, but on the venous side the communications between them are so free that, under conditions of intracranial stasis brought about by a growth producing an increase of tension, the venous return from the internal system is in large part shunted into the extracranial field. For this reason—though the

"tricks" to be spoken of apply chiefly to the internal system of vessels with a cerebral and meningeal distribution—it may not be out of place to preface a few remarks concerning ways of combating loss of blood from the external coverings, through which the approach to the more important structures must be made.

Throughout this paper the more critical cases will be considered. If precautions are taken to meet the serious problems of hæmostasis which the critical cases present, the simpler and less complicated ones can be more often carried through to a successful termination at one sitting. Furthermore, the discussion will be largely restricted to the osteoplastic type of operation on the cranial vault; for if its principles are mastered, operations in situations which forbid the use of a tourniquet or those in which a bone flap is prohibited may be conducted with comparative ease.

The Scalp.—That a trifling wound in a normally vascularized scalp may bleed abundantly is familiar enough. But when stasis of the extracranial vessels has been produced by a cerebral tumor, the loss of blood incidental to the long incision needed for an osteoplastic resection may be disproportionately excessive, unless precautionary measures are taken. Many devices have been suggested to control bleeding from the scalp, none of them in the long run being as efficient as a properly applied tourniquet. This, in any event, will control the arterial supply to the operative field, and if there is no cyanosis under the anæsthetic and no unusual widening of the emissary venous communications between the internal and external systems, not a single hæmostatic adjunct may be required. When, on the other hand, venous stasis has long existed and wide communications have formed between extra- and intracranial veins, the scalp will fill with blood and require the placement of clamps, no matter what device be employed. But even under these circumstances, the convex side of the incision towards the flap remains dry—a desirable result, as it avoids the risk of stripping scalp from bone through the weight of pendent instruments. When it is necessary to place

clamps on the concave edge, even though the bleeding points may lie in the tough scalp proper, it is best to catch the galea and allow the mere weight of the clamps to close the bleeding points. This precaution will avoid superficial points of tissue necrosis which militate against the subsequent reactionless healing. The flat T-shaped clamps which have been devised for the scalp are, I think, undesirable, for the reason that they are difficult to place and are likely to damage the tissues.

As many of these more desperate cranial operations must require two or more stages before their end, it is essential that the utmost pains be taken in closing the wound to assure an epithelial approximation which will permit early removal of the external sutures. Needless to say, if there are points of staphylococcal stitch infection, or even granulating edges owing to inaccurate closure, the reopening of the wound after a few days, and possibly the later re-reopening after a subsequent interval, is accompanied by especial risks of infection.

Our local method of closing these wounds is to bring the edges of the galea together by a series of interrupted and buried fine black (iron-dyed) silk sutures. This row of buried sutures oftentimes so closely approximates the overlying tough scalp as to render the placement of cutaneous sutures hardly necessary, were it not for the fact that they are destined to control the arterial bleeding which would otherwise ensue on the final removal of the tourniquet. A satisfactory method of placing these sutures before they are tied, by a row of round, fine intestinal (cambric) needles, has heretofore been described.¹ They should be removed after thirty-six or forty-eight hours; and by the fourth or fifth day the incision is hardly visible, there are no points of reaction due to suture constriction, and epithelium covers the entire field.

The present paper is not an essay on wound closure, though such an essay might well be written, for many, I am aware, regard this step as so unimportant a detail of an operation that its performance is beneath the dignity of the operating

¹ Keen's System of Surgery, 1908, vol. iii, Fig. 152, p. 272.

surgeon himself. It is, however, a deserving detail of these measures, not only when a subsequent reopening is premeditated, but for the reason that in the case of a fresh first-stage wound, especially when clamps have been necessitated owing to venous stasis, some further loss of blood will occur during the closure. For it is inadvisable to attempt to ligate the bleeding points in the tough scalp, as the external approximating sutures may be relied upon to effectually control them; and to place and tie these sutures accurately and rapidly requires a full and not a crippled operative team.

Impatience to attain results is characteristic of the species surgeon and often leads to the taking of unjustifiable risks—one of the reasons for the high mortality ascribed to major intracranial procedures, those for tumor in particular. The writer is no exception and constantly finds it necessary to curb himself in the desire to do just a little more. But far more tumor operations have been carried to a successful outcome by the courage to temporarily withdraw after a bad start than by banging at hazards. Annoying though it is, it may improve one's score when in difficulties to play back with the loss of a stroke.

Postponement may thus be justifiable merely in view of a badly taken anæsthetic—and no tumor patient in whom pressure is considerable takes the anæsthetic any too well, even with the most skilful administration. At a subsequent trial circumstances may be more fortunate, or a preliminary dose of scopolamin with morphia or atropin, or a combination of chloroform and ether, may serve to offset the earlier difficulties. For cyanosis increases intracranial pressure by accelerating cerebrospinal fluid secretion,² which adds to the venous obstruction and so to the loss of blood—a bad cycle all around.

² This is particularly true of ether, which, though the safest drug to employ, is unquestionably the most difficult to administer; and needless to say, its use should be in expert hands. There is less bleeding with chloroform, owing to the fact that it lowers arterial tension; but this in a way is comparable in its consequences to an actual loss of blood and so must be regarded as hazardous, as has been emphasized heretofore. And there are other hazards in the use of chloroform which formerly we did

But rare though it may be to have to abandon progress toward the final stage owing merely to a badly taken anæsthetic, postponement is not infrequently advisable because of excessive loss of blood from scalp and bone, and such a postponement would hardly seem an advance at all were it not for the fact that a blunt reopening of the uniting superficial wound after a few days is attended with relatively little bleeding.

The Skull.—All grades of vascularity may be encountered, and chief reliance must be placed upon the proper use of proper wax, for the introduction of which Horsley deserves the lasting gratitude of us all. The cases which present the greatest difficulties are those in which a superficial tumor of long standing receives or discharges much of its blood supply through the diploetic spaces of the bone. This is particularly true of the large dural endotheliomata, which are often associated with extreme vascularity of the adjacent skull, even though the immediately overlying bone may be thinned by pressure atrophy. The enlarged diploetic channels, in these cases, sometimes the size of a radial artery, are often traceable on the radiographic plates, which in this way may be useful even though they rarely show actual shadows of the tumor. At times the very surface of the exposed skull may be so roughened and vascular that it must be rubbed with wax to check the extensive oozing from countless points.

But even with the generous use of wax, considerable loss of blood may be unavoidable in the process of outlining the bone flap under these conditions of abnormal vascularity with extreme venous stasis. For though extravasation from the bone edges may be controlled, it is less easy to combat the free bleeding due to the separation of meningeal emissaries, particularly if the incision be carried into an area of new-formed arachnoidal villi with a distribution beyond the usual

not recognize, namely, the hepatic necroses which in greater or less degree are a constant feature of chloroform administration and are particularly extensive after a readministration, when, as Dr. George A. Whipple has found, there is an especial tendency even to spontaneous bleeding, owing to the loss or diminution of one of the elements necessary to clot formation.

confines of Pacchionian granulations. In any case it is well to give the longitudinal sinus and its lateral lacunæ a wide berth, and not to outline the mesial edge of the proposed flap nearer than two or three centimetres from the midline. Should an exposure of the foot area be deemed necessary the safest method of approach is to turn down a low flap and subsequently cut out a bay from the upper edge, leaving a permanent defect over this dangerous vascular area.

Whether one prefers to outline the bone flap with electro-motor or hand-driven instruments,—and I regard the latter as much the safer,—bleeding is likely to occur from the lacerated osteodural communications at the upper margin. For this reason it is our custom, after making the primary large trephine opening and the secondary opening with perforator and burr, to immediately pass a dural separator between the two, so as to break up the vascular attachments at this early stage. For when the instrument is withdrawn, the cerebral tension is sufficient to again plaster dura against bone and effectually check the bleeding, so that by the time the lateral margins of the flap have been cut, many of the emissary vessels will have become spontaneously occluded.

Postponement at this stage owing to loss of blood may sometimes be desirable, even before the flap, though thoroughly outlined, has been lifted away from the adherent dura. The advisability of this can often be gauged by the anæsthetist better than by the operator, and by a blood-pressure tracing better than by a finger on the pulse. The procedure up to this point has been a brief one, there will be a quick recovery from the anæsthetic, and a certain amount of pressure relief will be experienced through the slight elevation of the still adherent flap.

It is of course far more often possible to elevate the bone flap; for conditions such as may have rendered postponement advisable at a stage earlier than this are naturally rare. One must realize, however, that it takes nearly as long to get out of as it does to get into the intracranial chamber, and as there is likely to be about as much bleeding during the process of with-

drawal as during entry, such blood as may be lost during further advance must be multiplied by two. And one should not wait for a profound upsetting of the pressor mechanism, for it does not go to pieces gradually, but suddenly. This is well exemplified in transfusions, for a large amount of blood may be given up by the donor with no appreciable change in his condition, until a little pallor, increased respiration, and restlessness indicate the need of uncoupling. Checking the flow at this stage is followed by complete readjustment within a few moments, and one is often thus misled into the thought that more blood might safely have been withdrawn; but this extra straw will often so upset the regulatory mechanism that hours or days are needed for a complete restoration.

The Dura.—We have come to a stage of the osteoplastic operation which calls for especial tricks of hæmostasis, and the following adjuncts have been found useful: (1) *Small pledgets or "tips" of gauze* of various sizes secured by a black ligature, so that though blood-stained they can be easily located—minute Mikulicz pads as it were. (2) *Sterile absorbent cotton* to be used *dry* and plastered on an oozing surface, or *wet* in hot saline solution, a bowl of which at a temperature of 100° to 105° F. should be on the instrument tray immediately at hand. This dripping cotton is the best material for washing meningeal surfaces, and, when wrung out into flat pads, is the safest and most effectual substance for sponging or for temporary placement in deep cerebral wounds. (3) *Bits of living tissue*—supplied, for example, from the exposed temporal muscle—which serve admirably as a means of checking venous extravasation from points on the dura, and *fragments of partially organized blood-clots*, obtainable at a second-stage performance, are similarly useful. Finally (4) *silver wire "clips"* for placement on inaccessible vessels, which, though within reach of a clamp, are either too delicate or in a position too awkward for safe ligation.

On first elevating the flap there may be, particularly in cases with stasis, quite an abundant loss of blood from the raw surface of the dura. This bleeding comes from two sources,

arterial and venous; that from the latter being by far the more troublesome; for only in case of a torn meningeal at the lower anterior angle, due to its having deeply channelled the bone where this has been broken in turning back the flap, will arterial bleeding give trouble. When this occurs it is naturally the first thing to need attention, and if there is venous bleeding from the raw dural surface, it can meanwhile be temporarily controlled by promptly covering the whole surface with a large pad of the hot and dripping cotton, which is immediately dried out against the oozing dural surface by pressure with a gauze sponge. The arterial bleeding should then be checked without attempting to catch or ligate the vessel, which may be torn back "hang-nail" fashion. Some of the prepared gauze pledgets of proper size can be tucked under the bone, separating the dura from it until a point is reached where the vessel no longer channels the bone. Then the pressure of the pledgets against the tense dural surface will control the bleeding until later in the operation, when with an open dura the vessel can be caught by a "clip" if it proves to be inaccessible to a ligature.³

Permanent control of the venous bleeding is a more difficult matter. The artery, as its branches approach the upper part of the exposed area, is accompanied by many dural veins which have a more or less intimate connection with the bone, and many raw, bleeding points may be left after their separation. These points, especially if associated with Pacchionian granulations, may give a great deal of trouble during the further procedure, and indeed may continue to ooze after replacement of the flap and closure of the wound; and thus in the course

³Loose gauze pledgets of minute size, possibly a centimetre in circumference, are particularly valuable in ganglion operations. For one of them can be plastered against a bleeding point, say at the foramen ovale, and its anchoring ligature led out of the wound, leaving a sufficient exposure of the remaining field to allow for further progress in separating the dural envelopes. By using the proper tricks to control hemorrhage, in none of our last seventy-five cases has it been necessary to postpone a ganglion operation until a second session, and in none has it been necessary to place a drain.

of a few hours a thick extradural clot may form and give pressure symptoms. In our earlier experiences this was an occasional postoperative complication, and even now the possibility of its occurrence is always considered. The fact that dura and bone have been separated makes the formation of such an extradural clot possible, as the result of slow venous oozing, whereas in the ordinary extradural hemorrhage of traumatic origin, the extravasation comes necessarily from a ruptured artery. In other words, the tension of a purely venous extravasation under the latter circumstances would not suffice to peel the adherent membrane from the bone.

Even when the venous oozing seems at the close of the operation to have been effectually checked, postoperative vomiting or straining may start the bleeding anew by dislodgement of terminal thrombi, and for this reason in all cases in which the performance has been a bloody one the patient should not be lifted from the operating table until he has recovered in large measure from the anæsthetic. The table therefore should be made sufficiently comfortable by having a thick mattress covering, for it may be inadvisable to move the patient for two or three hours, and, indeed, it is not exceptional for critical cases to be kept in the adjoining recovery room over night before they are transferred to the ward. With such precautions, in addition to skilful administration of the anæsthesia, postoperative retching and vomiting are rare.

Oftentimes the gauze "tips" or pledgets of cotton, which, during the progress of the operation, have been used to cover and which have become adherent to bleeding points in the dura, cannot be removed without starting the bleeding afresh, so that one is occasionally tempted to leave the foreign material plastered against the dura in the hope of its becoming safely organized. This, of course, is undesirable (though we have found in animal experimentation that the cotton pledgets as a rule are well cared for) and also unnecessary, for an alternative has been discovered in *bits of living tissue* or *well-solidified blood-clots*. Small snips of tissue may be cut from an exposed raw surface, such as the temporal muscle—and muscle seems

to be particularly valuable as a hæmostatic—and when held for a moment on the bleeding point by a smooth instrument they will adhere more promptly and check further extravasation far better than gauze or cotton. Since this device for checking bleeding was first hit upon some two years ago, we have made frequent use of it, with most satisfactory results.⁴

It is possible that any living tissue will suffice. In a recent case of extirpation of a cerebellopontine tumor a troublesome point of venous bleeding was left at the side of the pons. It was controlled by a small piece of dura which, as the most available tissue, was cut off and plastered against the side of the brain-stem, adhering and effectually checking the bleeding after a few moments of gentle pressure. Organizing clots may also be utilized. They are particularly available in second-stage procedures; and at present, instead of scraping away the clots from primary trephine openings and discarding them, they are carefully preserved in saline gauze, and sections of them utilized in the same way as the bits of muscle tissue. Doubtless it will be found that tissue fragments can be prepared beforehand and kept sterile for this purpose.⁵

It is at this period—with a reflected bone flap and all bleeding from the dura checked—that postponement is most often advisable, not only on account of the loss of blood up to

⁴Since this paper was put together I have learned from Dr. Lund's interesting report of the visit last summer of the Society of Clinical Surgery to Great Britain that Sir Victor Horsley demonstrated "the hæmostatic action of a fragment of muscle" on the exposed brain during the progress of a laboratory experiment. It is not unlikely, therefore, and is indeed probable, that one or all of the "tricks" which I have here set down have been in use by others who have not regarded them of sufficient importance to record.

⁵If Bernheim's conclusions (*Jour. Am. Med. Assoc.*, 1910), that the walls of the blood-vessels possess more active clotting elements than do other tissues, prove to be correct the walls of preserved vessels may be applicable for this purpose; or the fibrin from whipped blood might be so prepared that it could be immediately plastered on bleeding surfaces, just as cotton is now used, and thus obviate the necessity for any subsequent replacement. Or, as Carrel has suggested (*Jour. Exper. Med.*, 1910, xii, 460) for the preservation of blood-vessels, we may be able to preserve tissues *in vitro* for these purposes in a condition of "latent life."

this stage, but more particularly should the membrane be so tense that cerebral protrusion of a dangerous degree is likely to occur through an immediate dural opening. Under these circumstances, even in the bone-flap operation, the principles of decompression come into play; for it cannot be emphasized too strongly that a rapidly forming hernia, comprising functionally important areas of a tense cortex which protrude through an immediately superimposed dural defect, often leaves irrecoverable paralyses. Hence, unless a tumor is obviously subjacent and there is every prospect of its removal at the first sitting, recourse should be had to a temporary palliative measure with a dural defect over a silent and preferably over the subtemporal area.⁶

In the making of a palliative subtemporal defect, whether a primary operation or one to be combined with a temporary osteoplastic resection, it is important that the fibres of the overlying muscle be preserved as intact as possible. This necessitates, particularly in the case of a primary decompression, the careful rongeur-ing away of the thin bone of the temporal region far under the edge of the split muscle, with an exposure of an area of dura carrying the main branches of the middle meningeal artery. Hence, when the dura is incised radially from a primary central opening to the margins of the bone defect, some of these branches, particularly the posterior radicle of the artery, are likely to be divided, and unless precautions are observed, bleeding may be troublesome. If the spoon-shaped spatula⁷ is used to hold the tense brain away from the dura while the radial cuts are being made, the arterial branches can usually be seen before they are divided, and a delicate clamp of the Halsted pattern can be applied on each side of the incised membrane even in the deeply overlain parts of the wound inaccessible for ligation. But what to do with these deep bleeding points after they were thus caught often

⁶ A useful method of combining at this stage a decompression with the exploration has been elsewhere described (*Surg., Gynæc. and Obst.*, vol. iv, 1909, pp. 1-5). It has been put into practice in some thirty or forty cases with uniform satisfaction in the results.

⁷ *Surg., Gynæc. and Obst.*, 1909, vol. iv, p. 3, Fig. 2.

gave us great concern in our earlier operations; and on one or two occasions it was necessary to divide the muscle transversely in order to obtain sufficient exposure for ligation. These difficulties have been overcome by means of silver "clips"—a device which possibly deserves the especial description given to it later in this paper.

The Brain.—The central nervous system can be seriously damaged in the attempt to employ the usual methods of hæmostasis with gauze, clamp, and ligature commonly used for other tissues. From its first exposure, every effort should be made to avoid any injury to the pia-arachnoid until the actual moment of entry to the subcortex for the purpose of exploration or enucleation of an obvious growth, and such entry and proposed enucleation must be carefully planned out in accordance with the disposition of the cortical vessels. A safe enucleation may be completely frustrated by gauze sponging or otherwise roughly handling a brain under tension, by the protrusion and rupture of the tense cortex through the primary dural opening, by the accidental injury of a cortical vein carelessly wounded during the enlargement of the dural incision. The struggle to control the consequences of these seemingly trifling matters, which leave in the end a large patch of broken and infiltrated cortex through which ligatures have cut and against which gauze sponges have been held, is only too familiar, and operations for tumor are usually terminated by such an occurrence.

Familiarity with the tricks of lessening tension is all-important in the prevention of these accidents, and the different methods of dealing with a "dry" or "wet" brain by primary decompression, by pricking arachnoid spaces, by ventricular or lumbar punctures, by changes of posture and what not, is a subject too large to be dealt with in the present paper, though indirectly bearing a close relation to loss of blood incidental to manipulations of the nervous tissues themselves. The whole matter hinges more on the disturbances of cerebrospinal circulation than upon the size and position of the tumor. For with a smoothly taken anæsthetic there may be little or no

difficulty in manipulating a brain holding the largest of growths, whereas cyanosis with increase of stasis may make the exposure of a brain, under previously normal conditions of tension, hazardous in the extreme. A small growth of the brain stem, on the other hand, may lead to a great stasis of fluid, the embarrassments from which can be promptly set aside by a ventricular puncture. In any event, a satisfactory subdural exploration can only be made after a considerable diminution in tension has been brought about in one way or another.

The question of tension, furthermore, is quite apart from the actual primary vascularity of the growth, for some of the most vascular lesions, which consequently are difficult to handle, fortunately may be uncomplicated by tension, just as tense brains may hold relatively non-vascular growths which are readily enucleable. However this may be, great care should be exercised in attacking a growth when once it has been brought into view and has been given the wide exposure essential to a safe attempt at extirpation.

Notwithstanding the statement of physiologists to the contrary, one rarely if ever sees "shock" in cerebral operations as a thing apart from hemorrhage or injury to some vital centre. This is abundantly supported by certain of our experiences with extensive cerebral manipulations at second-stage operations in unanæsthetized patients. Hence, with careful choice of the stage at which an extirpation may be attempted—meaning largely an unbled subject—an abundance of time and patience should be expended in the careful and slow manipulations necessary for the dislodgement of the tumor. The tearing out of a growth by the insertion of the fingers means a fragmental removal, extravasation and cedema from unnecessary damage, and blind points of hemorrhage most difficult to identify. On the other hand, it is astonishing how dry the subcortex may actually be if care has been taken in respect to the superficial vessels. One can usually find a safe point of entry through the cortex; and much of the remainder of the operation consists in the slow separation of brain from tumor,

working now here, now there, leaving small, flattened pads of hot, wrung-out cotton to control oozing for the time being from a given area, until it can be again attacked. I know of no better training in such procedures than can be gained by the experience of making clean-cut extirpations on the lower animals—let us say of the motor territory of the canine brain.

A few fine silk (bead) ligatures may be passed on delicate curved needles to secure some of the vessels crossing the line of proposed cortical (circumferential) incision if one is necessary, but care should be taken not to include the large *Venæ anastomoticae* or important branches of the middle cerebral artery, lest outlying areas of softening result and leave unexpected and unexplainable palsies to be answered for. Indeed, it is often surprising how widely one can push aside many of these vessels in the pia-arachnoid which at first would seem unquestionably to need ligation.

The actual tilting out of a tumor is largely a one-man performance, and the operator's left hand is necessarily occupied in holding and guarding the tissue in process of separation. The manipulations meanwhile are carried on by slow, blunt dissection with the right hand, while an assistant keeps the field clean by the careful use of wet cotton pledgets. During the progress of the measure, particularly in the case of a deeply seated tumor, vessels may be encountered passing from brain to tumor and lying in tissues in which it is obviously futile to place an ordinary hæmostatic forceps. Under these circumstances the silver "clips" to be described may be found to be useful, just as they are in the presence of dural bleeding from points awkward of access; for the jaws of the instrument holding the clip will pick up the visible vessel or bleeding point just as would the ordinary clamp, the "clip" being left to take the place of an actual pendent instrument.

Despite the rapidity with which the surrounding brain tends to fill up the gaping hole left by the final dislodgement of the growth, the raw surface of the cavity may continue to ooze. This condition can best be controlled by filling the hole with a wad of dry absorbent cotton which is replaced as it becomes

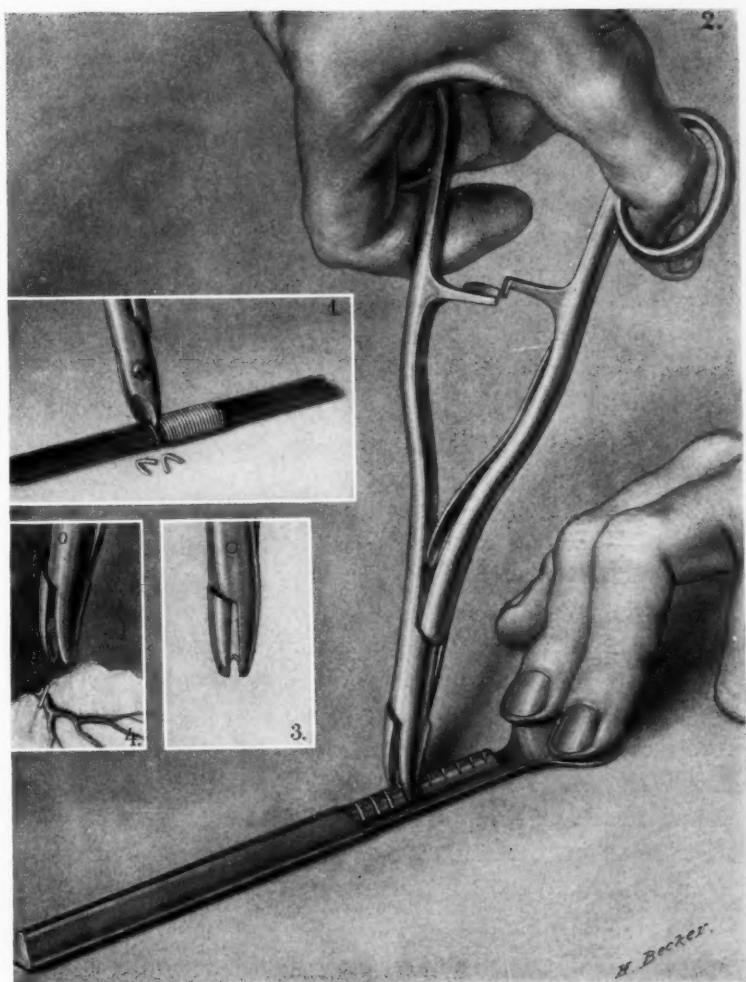
saturated. Ultimately the contracting cavity will be left sufficiently dry to justify closure without drainage, for a drain leading from the nervous tissues to the external world should never be used if it can possibly be avoided. The cavity, even if large, should be filled with normal salt solution, and the dura closed as accurately as possible over it. Even if it has been necessary to leave a defect in the dura overlying the cavity, the same principles are to be adhered to.

It was formerly our custom, in order to draw off the excess of bloody fluid as the brain tended to swell and fill the cavity, to leave one or two folded protective wicks, which were led from the cranial chamber through the primary trephine opening to a puncture in the scalp, outlying the original line of incision. For in this way an oblique passage is insured, and one which is easily occluded by pressure after the withdrawal of the wicks. But particularly in second-stage performances we have found this to be less and less necessary as we have learned how to leave a dryer wound. In the case, for example, of the tumor pictured in Fig. C., the huge cavity left by the removal of the growth was merely filled with salt solution, the flap replaced, and the wound closed with no drainage whatsoever.

SILVER-WIRE CLIPS AS LIGATURES

The thought has doubtless occurred to many that much time and trouble would be saved in major operations could there be devised some form of hæmostatic clamp, the mere placement of which would leave a fine, knotted ligature on the bleeding point so as to obviate the alternatives which we now possess, either of leaving a pendent instrument or taking the time necessary for ligation. Some one will probably have the ingenuity to construct an instrument of this kind, which will be useful not only for such extensive performances as complete breast amputations, where many delicate vessels must be secured along the axillary vein and where the temptation is great to leave dangling a heavy mass of clamps, but also in operations during which vessels are necessarily divided at

FIG. A.



Drawing to show (1) silver wire loops being cut after wrapping on grooved steel pencil; (2) one of the clips being picked up from the loaded magazine; (3) clip in position in jaws of holder; (4) clip placed on meningeal vessel at the edge of a dural incision, the empty instrument showing the mould for the clip. (Reduced one-third.)

FIG. B.



X-ray of a patient's head after subtemporal decompression, during which four clips were placed on bleeding points in the dural margin. Showing unobstructed view of normal sella turcica, two of the clips being in line with its posterior border.

FIG. C.



Dural endothelioma (actual size) with adherent clips. Tumor successfully extirpated at second stage, weighing 200 grammes. Bone-flap operation; closure without drainage; uncomplicated recovery.

FIG. D.



Clips adhering to the inferior thyroid stump of an enucleated intra-thoracic goitre (slightly reduced).

depths easily reached by a clamp but in positions awkward for ligation. It was doubtless this thought, coupled with a knowledge of the ingenious instrument used by some surgeons for closing skin wounds by the superficial placement of removable, toothed metal bands, that led to the device which we have come to employ.

Some three years ago a small U-shaped bit of wire held in the jaws of an ordinary clamp was first successfully used to check bleeding from a troublesome meningeal vessel divided in a subtemporal operation. As further trials were made on subsequent occasions, the difficulties of holding the small bit of wire in position were overcome by an indentation (Fig. A, 4) in the blades of the clamp in which the wire could securely lie. The wire U's have finally come to be made in large numbers and of equal size by cutting them from a flat metal pencil, around which the wire has been previously wrapped (Fig. A, 1). In order to furnish clips which will not slip easily from the tissues on which they are placed, the metal pencil is longitudinally grooved, so that by lightly tapping the wire, after winding, the inner surface of the loops become transversely ridged. A deep median groove allows the pointed wire-cutters to snip the several loops (Fig. A, 1) of the same size. They are then loaded on a magazine and picked up individually, as needed, by the holder (Fig. A, 2). The first "catch" of the holder locks its sprung handles at a point which closes the jaws sufficiently to enable them to take up the loop from the magazine without deforming the easily compressed wire, and the instrument unlocks itself when the U has been flattened against the bleeding point (Fig. A, 4). These matters are made sufficiently clear by Mr. Becker's excellent drawing without further description.

The instrument in its present form has been put to use at some stage or another in almost all of our operations on the brain for the past year or two. Like any tool, however, a certain amount of experience is necessary before it can be used with facility. In the hands of some ingenious mechanic it would doubtless be capable of much greater perfection; it

would be well to have a self-loading tool if one could be constructed without its being too cumbersome.

The "clips" have been found useful for the occlusion of inaccessible vessels divided in the dural incisions of decompressive operations (Fig. B), for the occlusion of the meningeal at the foramen spinosum if its division is advisable during the operation for trigeminal root avulsion, and, as has been stated, during the enucleation of cerebral tumors for the occlusion of the vessels passing from cortex to tumor—vessels the position and delicacy of which often make ligation well-nigh impossible (Fig. C).

Though from the present character of my operative work I have had little opportunity to test the value of these silver "clips" in operations other than those on the brain, I can recall occasions in intra-abdominal work when the instrument would have been most useful—occasions when a bleeding vessel, such as the artery of the cystic duct, in the depth of the wound could be caught by a clamp but in a position difficult for ligation, particularly if the operator's left hand was occupied in holding the viscera aside to secure the necessary exposure. The "clips," however, have been utilized in a recent enucleation of a large intrathoracic thyroid tumor (*goitre plongeant*) in a case of acromegaly. The tumor, the descent of which had doubtless been encouraged by the skeletal enlargement of the upper thorax, had exerted pressure against the superior vena cava, and venous stasis of the entire upper body was so extreme as to give an appearance of a malignant mediastinal growth. During the process of dislocating and delivering the growth from its subclavicular position, many of the inferior thyroid vessels below the clavicular level were clipped before their division in positions which would have made ligatures very difficult to apply and the placement of a number of clamps out of the question (Fig. D). "Clips" similarly have been successfully used by Emil Goetsch in such delicate procedures as the experimental occlusion of the canine hypophyseal stalk, and by L. J. Crowe for securing the bleeding points after a tonsillectomy. It is not improbable that similar instruments

fashioned to carry loops of stouter wire and of larger calibre might prove useful in occluding vessels larger than those for which we have heretofore used the device.

Summary.—One of the chief objects of concern in intracranial surgery should be the avoidance of any unnecessary loss of blood, for at best, in many cases of brain tumor associated with venous stasis, bleeding is likely to be so excessive as to necessitate postponement of the final steps of the procedure until a second or even a third session.

The common methods of blood stilling by sponge, clamp, and ligature are largely inapplicable to intracranial surgery, particularly in the presence of bleeding from the nervous tissues themselves, and any device which serves as an aid to hæmostasis in these difficult operations will bring a larger number of them to a safe termination at a single sitting, with less loss of blood and less damage to the brain itself.

In addition to the more familiar tourniquet for the scalp, and wax for diploetic and emissary bleeding, suggestions are offered as to the use of gauze pledgets, dry sterile cotton, fragments of raw muscle and other tissues, as well as sections of organizing blood-clots for superficial meningeal bleeding, and silver "clips" for inaccessible individual points either in dura or brain.

The successful consummation of any critical operation often depends upon seeming trifles. It is, however, the scrupulous observance of surgical minutiae that makes possible the safe conduct of major intracranial performances—performances which a few years ago were attended in most cases by a veritable dance Macaber.

SUBLUXATION OF THE ATLAS.

REPORT OF TWO CASES.

By **LEONARD W. ELY, M.D.,**

OF DENVER, COLO.

IN *ANNALS OF SURGERY*, vol. li, No. 2, appeared two articles dealing with subluxation of the atlas on the axis, one by Mixter and Osgood, and the other by Pilcher. One showed the good results of a necessary operation, and the other the favorable outcome of a case following a fruitless surgical interference, that is, under practically no treatment except that by a retentive apparatus for a time after the operation.

The two cases I would report include one similar to Mixter and Osgood's, and one similar to Pilcher's.

In the article by Mixter and Osgood appears a review of the bibliography¹ of the subject, as well as the study of the mechanics of the lesion.

The history of the operative treatment of spinal fractures and dislocations is a disheartening one. Some of the most enthusiastic advocates of radical measures have little on which to base their recommendations but a list of disastrous failures. If the cord be badly crushed, operation is evidently quite use-

¹In addition to the cases cited by Mixter and Osgood the following may be mentioned. The list is probably not complete:

Eisendrath: Rotary dislocation. Death a few minutes after a fall upon the head from a bicycle. Death caused by "slipping backward of odontoid process." Ligaments torn. Specimen at autopsy. *ANN. OF SURG.*, xlii, 245.

Corner: *ANN. OF SURG.*, xlv, 9, Rotary Dislocations of the Atlas. Gives 20 cases, including two of his own. Some died immediately, some later, some were reduced by extension and manipulation. He thinks the lesion is fairly frequent.

Wilson: *ANN. OF SURG.*, xlv, 632.

Bogardus: *International Journal of Surgery*, vol. xxiv, No. 2.

A very interesting description of this lesion may be found in *Deutsche Chirurgie*, 1878, Lief 40, S. 284. *Die Verletzungen der Wirbelsäule und des Rückenmarks*, von W. Wagner and P. Stolper.

less, but apparently it is not always possible to tell before operation whether the cord is crushed or only suffers from pressure. If the latter, then operation planned without a definite and logical idea will not suffice to cure. The procedure of Osgood's is brilliant in the extreme, very ingenious, and shows what can be accomplished by a well-timed and correctly planned surgical interference. A reference to standard text-books and to medical articles will show that the prognosis heretofore has been practically hopeless.²

CASE I.—W. W., age thirteen, occupation, schoolboy. Seen May 11, 1909, Roosevelt Hospital, Out-Patient Department.

The patient says he was sick with rheumatism in his right ankle, knee, and shoulder last autumn, for a period of two

² Scudder: *The Treatment of Fractures*, Philadelphia and London, W. B. Saunders Co., 1907, p. 94. "Injuries to the first two cervical vertebræ. If the displacement is slight, life may be spared until sudden displacement occurs or a secondary myelitis causes death. Cases of recovery are recorded. Death usually occurs immediately. Perhaps one person in fifty thus injured recovers (Gowers)."

Hopkins: *A Clinical Treatise on Fractures*, Philadelphia, J. B. Lippincott Co., 1900, p. 187. "Fractures of the atlas and axis are usually immediately fatal through the almost inevitable injury to the medulla accompanying them."

Cotton: *Dislocation and Joint Fractures*. "Dislocation of the atlas on the axis—such dislocation is possible only when the odontoid process is slipped out from under the transverse ligament, when it tears through this ligament, or when the odontoid itself is broken and displaced—the last being most common."

"In almost all these cases the luxation of the atlas is forward—in some cases forward and to one side."

"So few of these cases of injury to the first two cervical vertebræ survive the trauma that data for diagnosis are scanty."

"Open operation—laminectomy—seems to show no encouraging results in this class of high lesions."

Helferich: *Fractures and Luxation*. "Both of these are generally fatal," i.e., luxations between occiput and atlas, and between atlas and axis.

Roswell Park: *Surgery by American Authors*. "The symptoms of injury to first, second, and third cervical vertebræ are death."

Da Costa: *Modern Surgery*. "Fracture dislocation of the atlas or axis usually causes instant death. When the displacement is only trivial, the patient may actually recover, but will probably die of secondary cord disease."

months. He recovered completely, and about one month later his neck grew stiff, and has been stiff since. He suffers some pain.

Examination shows a boy in good condition. His face is turned to the left, but his head is almost erect. Respiration is rather loud. Marked stiffness and spasm are present in the neck muscles, and the motions of the head are limited in all directions. A sharp prominence of the spine at about the third cervical is plainly evident.

A skiagram reveals a forward dislocation of the atlas and head upon the axis.

Treatment.—A grand Calot jacket was applied. While the patient was suspended, an attempt was made to reduce the deformity, but in vain.

Oct. 4, 1909: Plaster jacket removed. Marked restriction of rotation of the face toward the right is present, but other movements are fairly free.

Nov. 22, 1909: The patient feels perfectly well, and plays with his comrades. His face is still turned to the left, and this turning motion to the left is the only free one in the neck. The boy now admits that he fell on the ice nine months ago while skating, and that the symptoms supervened immediately.

April 25: No change as to local condition.

The second case is so instructive that it may well be detailed at length:

CASE II.—B. B., male, sixteen years old, glassworker, patient of Dr. V. H. Norrie. Seen in consultation at Bellevue Hospital. Admitted Sept. 2, 1909.

Nine weeks ago the patient fell down an elevator shaft, nine feet, striking on the left side of his head. He was unconscious for two or three minutes, then walked with assistance to a drug store. He bled from a scalp wound, but not from the ears, mouth, or nose. His wounds were dressed and he went home, free from paralysis and stiffness, but with a pain in the upper thoracic spine and in the left side of his head. The spinal pain disappeared the next day, but the headache persisted for four weeks.

Three days after the injury the patient's neck began to grow stiff and to pain unless the head was held carefully to the right

FIG. 1.



Skiagram of Case I.

FIG. 2.



Note characteristic attitude
of head. (Case I.)

side. Five weeks ago Dr. Carl Beck took an X-ray plate and put the neck up in plaster, with the head straight, for two weeks. On taking off the plaster, the head again deviated to the right and the stiffness persisted. The patient removed the plaster without permission, because he was tired of it.

Eight days ago, the patient felt cold and had a feeling of numbness and tingling, followed by marked sweating. He was put to bed and became gradually paralyzed, first in the left arm, then partially in the left leg. He has had no sensory symptoms but has had partial incontinence of both urine and fæces.

Chief complaint, pain and stiffness in neck, and paralysis.

The following notes of the physical examination are copied from the hospital history:

General Appearance.—The patient, a boy about fifteen years of age, well nourished, good color, of good musculature, lying in bed and complaining of pain in the back of his neck, and of paralysis.

Paralysis: Complete of left arm, forearm, and hand. The patient is unable to move the arm off bed or to grasp anything with his hand. His grip is lost. The right arm is incompletely paralyzed. The patient can raise his forearm off the bed and he has slight use of his fingers and of his hand. The grip is almost entirely lost. Left leg: impairment of power is present, more marked in leg and foot than in thigh. The patient drags his foot and leg after him when he walks, and his left foot is never raised more than an inch above the floor.

Cervical region: The boy holds his face turned towards the right side. He does this, he states, to ease the pain. There is a distinct swelling in the suboccipital region, and there is a marked rigidity of right and left recti postici obliqui superior and inferior, also of rectus lateralis. There is pain on pressure over this region, and on extreme flexion and extension. The lateral movement is entirely free and normal, and causes no pain. Flexion and extension are limited and painful. There is no bony crepitus, and the cervical vertebræ are in a straight line, with the possible exception of the second and third, which seem to be out of line.

Sensory disturbances are not sharply defined. There is an area of absolute anæsthesia about the size of a small saucer in the right upper lumbar region. Below umbilicus, there is a

diminution of sensation to pain on the left side; above, there seems to be no change.

The left side of the face is flatter than the right, but is only slightly changed.

The pupils of the eyes are equal, and react to light and to accommodation. No ptosis, strabismus, nor nystagmus is present.

The tongue does not deviate.

Reflexes: Knee-jerks are greatly exaggerated, more marked on left side than on right. Cremasteric is present on left side, absent on right. Abdominal reflex is equal on both sides. Babinski's sign is present on the right, not on the left side. Kernig's sign is absent on both sides. Ankle clonus is extremely well marked, and seems to be the same on both sides.

Patellar clonus is marked on both sides. Ulnar nerve; some anæsthesia is present on both sides. The diaphragm has normal movement. Mentality is normal. Convulsive movements and fibrillar twitching of entire left leg and, at times, of a single group of muscles, can be seen.

The throat is normal. Speech is unaffected. The teeth are in good condition. The mouth at times is drawn to the left side; this is inconstant.

The chest is of good type; wide expansion, the same on both sides. There are no adventitious signs.

Heart: Upper border in third space, left border, $3\frac{1}{4}$ inches out, right border at right edge of sternum. Apical impulse in fourth space, 3 inches from midsternal line. No murmurs are present, nor accentuation of first sound at apex.

The pulse is regular, rate 76, good quality, good excursion.

The abdomen is slightly distended. There is no tenderness, no fluid, no masses.

Liver: The lower edge cannot be felt, percusses from fifth space above.

Genitals, results of a normal circumcision.

Lymph-nodes: Axillary, epitrochlear, cervical, and inguinal are of normal size.

A peculiar point about the sensory symptoms was that they changed from day to day.

A skiagram showed a subluxation of the atlas on the axis (see Fig. 3).

FIG. 3.



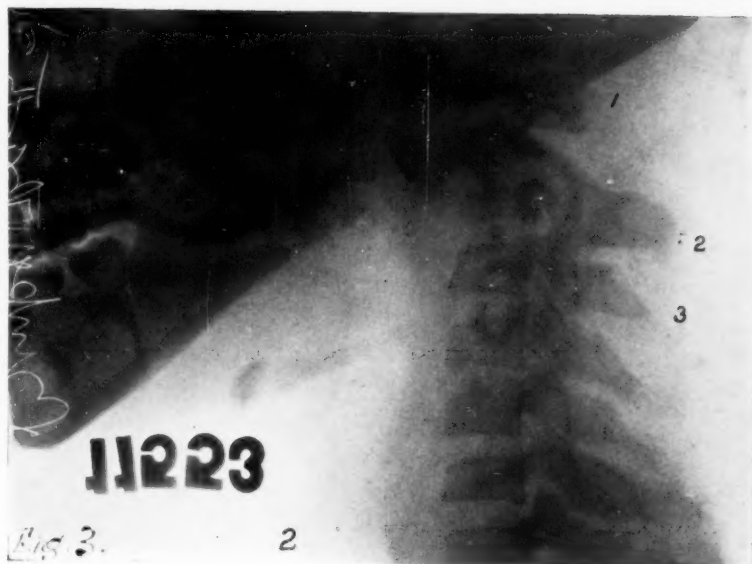
Skiagram of Case II, taken before treatment was begun in Bellevue Hospital.

FIG. 4.



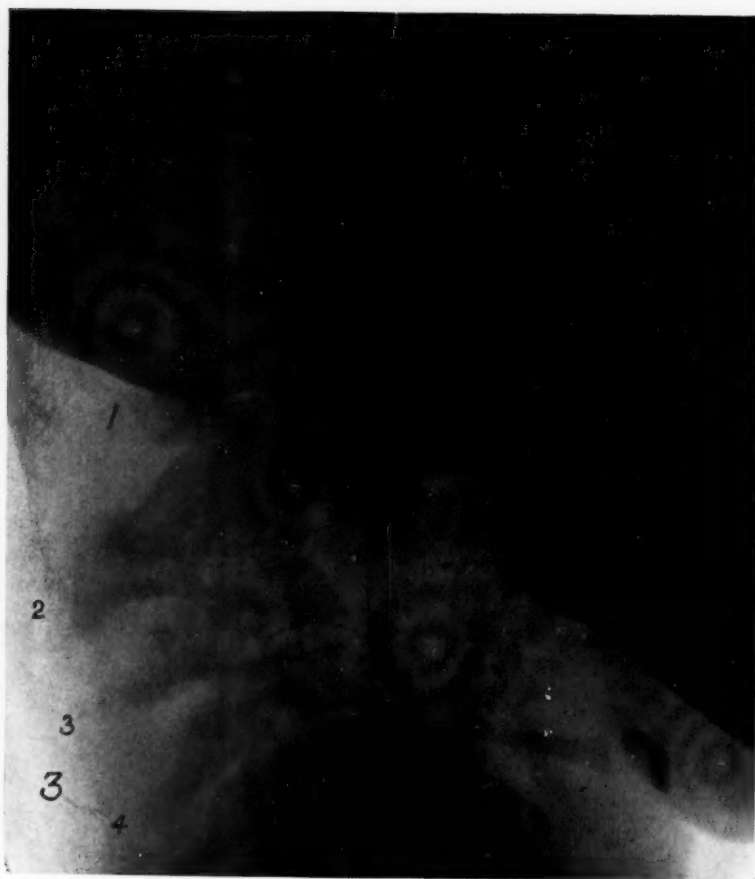
Photograph of patient standing, shortly after the first jacket was applied. (Case II.)

FIG. 5.



Skiagram taken Nov. 20, 1909, after the removal of the first jacket. (Case II.)

FIG. 6.



Skiagram taken January 12, 1911, seven months after the operation. (Case II.)

Sept. 7, 1909: A plaster collar was applied from lower chest to ears by Dr. Ely, covering the chest, neck, and chin up to the ears, and holding the head in extension (Fig. 4). The patient was strung by a Calot head sling, and on account of the paralysis, practically complete in the lower extremities, he simply hung by the neck, limp. He is comfortable, free from pain, and takes food well.

Sept. 10, 1909: General condition is excellent. Power in extremities has much improved. The right leg is practically normal, the left leg is slightly weak, but all movements can be performed. The patient is able to walk.

The right arm is much stronger than three days ago. It can be raised to the patient's head, and the elbow, wrist and fingers can be flexed and extended. The grip is fair. This arm was slowly losing power up to Sept. 7, 1909. The left arm, which was completely paralyzed on admission, has regained considerable power. All movements can be made, but rather feebly and with considerable effort. The grip is rather weak. The hand can be elevated to the nose, but the movement is uncertain. No sensory disturbance can be made out. Sept. 14, 1909: Ankle clonus and increased reflexes still present. Flexors of the left thigh are weaker than those of the right.

Sept. 15, 1909: The patient and Dr. McLean think that power in arms and hands is not as good as several days ago.

Nov. 15, 1909: Power has steadily but slowly increased in legs and arms. The patient has a good grip, and can raise his hands above his head. He walks fairly well. The left arm and lower extremity are distinctly behind the right in power. In shaking hands with the left, there seems to be a sort of tardy impulse—the fingers do not catch hold for an appreciable fraction of time, one or two seconds.

Plaster removed. A small prominence is apparent at level of axis, and the face is turned to the right. Some motion is present in head, but limitation is present of flexion, of extension, and of rotation. The patient will go without plaster.

Nov. 20, 1909: Skiagram (Fig. 5).

Nov. 25, 1909: Boy walks around, but says his left arm is not as strong as it was. He was knocked over recently.

Nov. 29, 1909: Dating from the fall, the boy has grown steadily worse. His hands and arms are very weak. He is

hardly able to stand, and the power in both hands is distinctly less. A new jacket was applied to-day, similar to the other. When the patient was slung up, a decided attempt was made to reduce the deformity, but without avail.

Nov. 30, 1909: Immediate improvement in power. The patient can again lift his left hand to his head, and his grip, which yesterday registered zero, to-day registers 15. Power in the right hand is also much greater (Norrie).

Jan. 3, 1910: Steady improvement since last note. The patient walks well. He can climb stairs, and has good power in his hands and arms. The knee-jerks are exaggerated. The patient can distinguish heat and cold. No dragging of legs can be perceived.

March 18, 1910: Plaster of Paris jacket removed by request. Boy refuses operation. Excellent power in hands and feet. Knee-jerks are exaggerated. Thickening is present about region of injury. Deformity can be felt in back of throat.

May 20, 1910: Paralysis has steadily and slowly returned. New jacket.

June 20, 1910: Paralysis has steadily and slowly disappeared. Jacket removed.

June 22, 1910: Mixter and Osgood's operation at Metropolitan Hospital. Wound sewn up without drainage. The attempt to anchor atlas over the spinous process of axis was unsuccessful. Therefore with strong silk, the posterior arches were tied tightly together, while the anæsthetist made an attempt to reduce deformity through the mouth. Plaster of Paris was applied from chin and occiput to upper part of chest as formerly.

July 11, 1910: Almost complete paralysis of limbs and of bladder and rectum followed the operation. This has slightly improved. To-day the plaster was removed. The distortion of the head had mostly disappeared, and the deformity at seat of the lesion was much less. Pressure sore under chin. The patient was slung up with Calot sling, and a new collar (jacket) similar to the others was applied, cut out under the chin for the pressure sore.

In July I moved to Denver, but kept in touch with the patient by letter.

July 30, 1910: A letter from the house surgeon of the Metropolitan Hospital says that the patient is gradually improving.

FIG. 7.

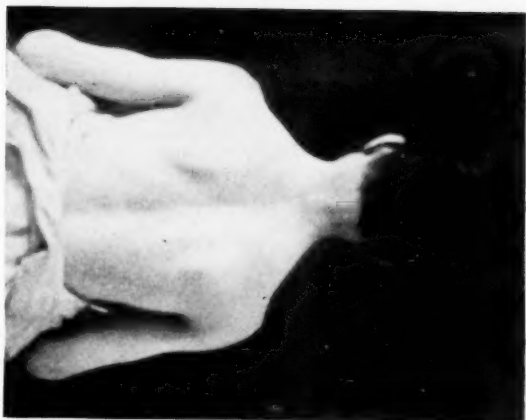
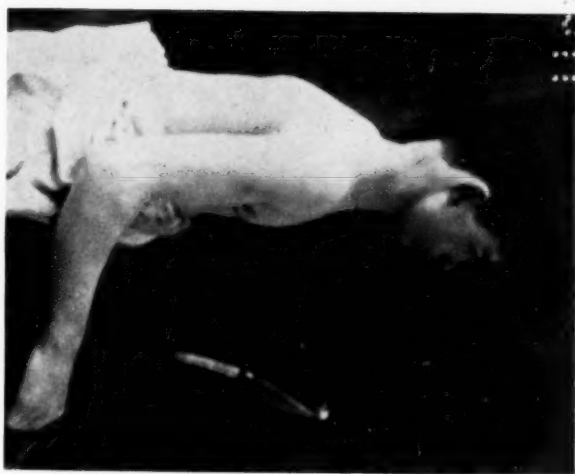


FIG. 8.



Photographs of patient taken in April, 1911, ten months after the operation. (Case II.)

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Power is increasing in legs and arms, and the control of bowels and bladder is being resumed. The boy sits up for four hours a day.

Sept. 11, 1910: "Benjamin continues to improve. He walks about the ward, and does light work. His right side is normal, but the left arm and leg are weak and tremulous. Improvement on this side is slow."

Nov. 1, 1910: Plaster removed.

Jan. 1, 1911: Left Metropolitan Hospital.

Jan. 12, 1911: Skiagram was taken by Dr. Chas. Eastmond, of Brooklyn (Fig. 6).

Jan. 28, 1911: The patient called upon Dr. Albee, and to Dr. Albee I am indebted for the following notes:

"He walked into the office as if he had never been paralyzed or had broken his neck. He has complete use of his arms. The strength of the forefinger of the left hand is considerably impaired, but the rest of the hand is all right. There is a prominence over the second, third, and fourth spinous processes. The neck is very straight, and the upper normal curvature of the thoracic spine is diminished. There is a compensatory lordosis. The anteroposterior motion is limited, as is also rotation. Motion, active or passive, is not painful. The knee-jerks are somewhat increased, especially on the left side. It is a great case."

Feb. 28, 1911: The patient writes that he goes to school, and is taking up *stenography and typewriting*.

April: Photographs of the patient were taken by Dr. Napier, Figs 7 and 8.

May 20, 1911: The patient was seen by me to-day. He is in excellent condition, can walk and run and climb stairs, and has a good grip with both hands. His head sits practically straight on his shoulders. There is a small knuckle over seat of lesion. The knee-jerks are somewhat increased. No ankle clonus is present. All motions of neck are somewhat restricted.

There are numerous suggestive points in this history: Conservative treatment, tried for about a year, had been a failure, in so far as the cure was concerned, though each time that a plaster jacket was applied the symptoms abated.

The cord, though evidently compromised by the pressure, was not seriously damaged, and resumed its functions as soon

as the pressure was relieved by the slight amount of replacement afforded by the plaster.

The marked preponderance of symptoms on the left side showed that the subluxation had taken place on the right atlo-axoid joint as an axis. In other words the luxation was not a rotary luxation, properly so-called, but the left atlo-axoid joint had parted.

In order to permit this luxation, the transverse ligament must give way, or the odontoid process must slip out from under it, or the odontoid process must be fractured. A study of the two bones makes the last the most probable solution. If the odontoid process held fast it would probably cause instant death from pressure. Other writers have reached the same conclusion.

Although the atlas is decidedly out of place, the anchoring of its posterior arch to the arch of the axis has relieved the symptoms.

Operation is not always hopeless in spinal fractures and dislocations if it be undertaken with a logical idea.

Finally: The patient described in Case I, though apparently cured, is liable to die suddenly at any time by increase of the displacement. This result has been observed in many cases. On the other hand Pilcher's case was alive and practically well nine years after the injury. In our second case it would seem that as long as the silk ligature holds fast, the displacement cannot recur. At any rate, the operation has restored to practical health a patient who could not live without a cumbersome apparatus.

The following articles on spinal fracture will be found interesting:

Thorburn: Brit. Med. Jour., Oct. 27, 1894.

Lloyd: Am. Jour. of the Med. Sciences, July, 1889.

Lathrop: ANNALS OF SURGERY, vol. xxxii, 1900, p. 834.

Lloyd: Jour. Amer. Med. Association, April 13 and 20, May 4, 1901.

Lloyd: Phil. Med. Jour., Feb. 8, 1902.

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Walton: Jour. of Nervous and Mental Diseases, vol. xxix, 1902, p. 1.

Bolton: ANNALS OF SURGERY, vol. xxx, 1890, p. 172.

- Leckie: Brit. Med. Jour., Oct., 1892, p. 786.
 Mixter-Chase: ANNALS OF SURGERY, vol. xxxix, 1904, p. 495.
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 Boston, 1900, p. 1.
 Oliver: ANNALS OF SURGERY, vol. xxxvii, 1903, p. 239.
 Clark: Med. Record, Sept. 8, 1906, p. 575.
 Haynes: N. Y. Med. Jour., Sept. 22, 1906, p. 583.
 Stewart and Harte: Phil. Med. Jour., 1902.
 Honan: Medical Times, 1900, xxviii, p. 217.
 Pyle: ANNALS OF SURGERY, 1894, xix, p. 664.
 Bastian: Med. Clin. Trans., 1890, lxxiii, p. 151.
 Warren: Boston Med. and Surg. Jour., May, 1899.
 Starr: Amer. Jour. Med. Sciences, vol. civ, 1892, p. 15.
 Knapp: Jour. of Nervous and Mental Diseases, Sept., 1897.
 Phelps: Jour. of Nervous and Mental Diseases, 1893, p. 407.
 Abbe: Medical Record, March 3, 1900, p. 353.
 Swan, Powers, and Pershing: Medical Record, vol. lxxix, No. 15.

THE TREATMENT OF ANEURISM OF THE ABDOMINAL AORTA BY PARTIAL OCCLUSION OF THE AORTA WITH THE METALLIC BAND—THE EFFECT UPON THE URINARY SECRETION OF THIS PROCEDURE.

A REPORT OF TWO CASES.

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THERE are 15 recorded cases of ligation of the abdominal aorta,¹ and one case of ligation of the thoracic aorta.² All have ended fatally. The cause of death, according to Katzenstein³ and to Offergeld,⁴ who recently have made thorough studies of the results of aortic ligation, is cardiac failure caused by the terrific strain which this operation puts upon the heart. These investigators agree that the operation is unjustifiable when there is the least question of cardiac or vascular disease.

Healthy laboratory dogs not infrequently may survive complete occlusion of the aorta. When they do so their hearts at autopsy show hypertrophy. Animals withstand, however, a partial occlusion of the abdominal aorta very well (Halsted⁵). Likewise in man a gradual occlusion of the vessel by thrombosis is sometimes survived. These facts have led several writers—Halsted, Keen,⁶ Stratton⁷—to suggest gradual occlusion as a method of treating aneurism of the aorta and to contrive instruments for this purpose. The two cases of abdominal aortic aneurism, here reported, were treated by partial occlusion of the aorta by means of the aluminum bands devised by Professor Halsted. In both cases the bands were applied above the origin of the renal arteries. In one of these cases two bands were applied, the first to the thoracic, the second to the abdominal aorta. Thus an excellent opportunity

was afforded for study of the effects upon the urinary secretion of a sudden fall in the blood-pressure of the kidneys. After each of the three operations on the two cases, there appeared for several days in the urine a great number of long waxy casts. This finding was so striking, that it is thought it might prove of diagnostic value in determining the sudden occurrence of obstruction of the aorta above the origin of the renal arteries, or of the renal arteries themselves.

CASE I. (Surg. No. 20092).—E. S., age thirty-six, colored, was admitted to the Johns Hopkins Hospital to the service of Professor Barker, December 5, 1906.

Complaint.—Great pain in the upper part and sides of the abdomen, and in the back.

Family History.—Irrelevant.

Personal History.—The patient had always enjoyed vigorous health up to his present illness. The following facts significant as having a probable causal relation to his trouble: (1) he had had syphilis 10 years before admission; (2) he had used alcohol to excess; (3) he had always done very hard work—teaming and heavy hauling.

Present illness.—In July, 1905, while lifting, the patient "felt something give way inside his abdomen." For a few days following this he had pain in the epigastrium when coughing, but the trouble soon subsided and he continued at work.

On July 4, 1906, at noon, he had a sudden "grumbling, boring" pain in the epigastrium. This pain was constant after the onset. Five weeks before admission it became very much worse. He said that the "jolting of the wagon almost set him wild." The pain was localized in the abdomen midway between the navel and the ensiform cartilage, and extended thence to the back. It was made worse by coughing, by movement, and at times by taking food. He had lost 60 pounds in the five months prior to admission. It is uncertain just when he first noticed the abdominal tumor, but it was probably about five weeks before admission.

In the few days just before he entered the hospital, the tumor had rapidly increased in size. On the day of admission the pain became so agonizing that he frequently had to stop his team to relieve it. He said that he "finally had to give up."

Physical Examination.—The patient was a powerfully built colored man. The thoracic and abdominal viscera were found to be practically normal. The only thing of significance discovered on physical examination was an abdominal tumor. On December 9 Professor Osler saw the patient and dictated the following note:

"The patient is a robust, muscular looking man. He has no extreme degree of sclerosis. The temporals are scarcely palpable. In the abdomen, in the epigastric region, midway between the navel and the ensiform cartilage a definite swelling is seen. The pulsation itself extends from the ensiform to the navel and from there beyond the right parasternal to the left mammillary line. It looks distinctly undulatory, appearing much more wide-spread than the usual pulsation seen with a throbbing aorta. The costal border is not elevated with pulsation. No pulsation below navel. The visible tumor undergoes no change. There is much more pulsation to the left than to the right of the midline. No pulsation behind. On palpation the abdomen is everywhere soft. Above the navel the patient is tender. Occupying the left side of the abdomen, above the navel, there is a large tumor, pulsating, expansile, outlined definitely between one's hands. Pulsation is very forcible, feeling directly under one's fingers. Has the same characteristic as a cardiac or arterial pulsation. No thrill. Shock of neither sound is palpable. There is a loud, systolic murmur."

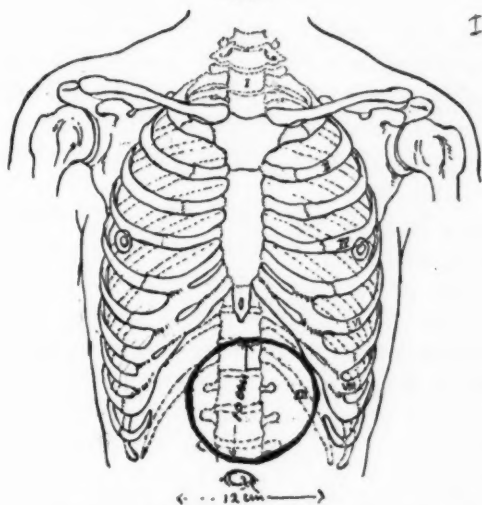
The patient's red blood-cells were 5,000,000, the white cells 6600, and his hæmoglobin 95 per cent. A diagnosis of aneurism of the upper part of the abdominal aorta was made.

On December 17 he was transferred to the service of Professor Halsted, who operated upon him on the 18th, making a partial occlusion of the thoracic aorta with an aluminum band, as near to the diaphragm as was easily feasible.

Operation I: The patient was placed on his back and given ether, his head in a positive pressure box. He was then turned on his side and an incision 36 cm. in length, in the seventh left intercostal space, beginning anteriorly at the costal cartilages and extending almost to the rib angles, was made. The muscles were cut through, keeping near the upper margin of the rib. Practically no bleeding was encountered. After the pleura was opened, the lung was permitted to collapse quite rapidly to a semidistended state. The ribs were then forcibly separated with a

spreader and a wide exposure thus obtained. Fracture of a rib did not occur, but some of the costal ligaments may have been torn. There was no great change in the patient's condition when the thorax was opened, except for an acceleration of the respiratory rate and a quite well-marked fall of blood-pressure. The areolar tissue about the aorta was dissected away and a heavy white braided silk was introduced with a blunt aneurism needle beneath the aorta, possibly at a point to 10 cm. above that at which it passed through the diaphragm. An aluminum band which

FIG. 1.



The aneurism and its relations. (Case I.)

had been previously prepared (of No. 29 sheet aluminum), about 7 cm. in length and 2 cm. in width, with a rounded end, was then made to encircle the aorta. The band was tightened by rolling with the fingers and unrolling prevented by a silver ligature which embraced it. The circumference of the aorta at this point, although not measured, was estimated at 8 or 9 cm.

The patient's blood-pressure at the beginning of the operation was 125 mm. in both arm and leg. After the band was tightened it was 105 mm. in the arm and 55 mm. in the foot.

The operation was performed without the aid of the apparatus for maintaining the distention of the lung. During the closure of the chest the positive pressure cabinet, devised and manipu-

lated by Dr. Richard Follis, was made use of to inflate the lung.

The patient recovered promptly and without incident from the operation. He had neither sensory nor motor disturbance of the legs. The wound healed per primam. The blood-pressure in both arm and leg was taken at frequently intervals. A half hour after the application of the band the pressure in the leg had risen to 100 mm., that in the arm being 120 mm. at the same time. After this the pressure in the leg at times seemed to be equal to that in the arm, though it tended to remain 10 to 20 mm. lower.

The patient's chest was examined on the day after the operation by Dr. C. P. Emerson, at that time resident physician of the hospital, who could find no evidence of pneumothorax. He thought there might be a very slight accumulation of air in the left supraclavicular fossa. The patient was for a time almost completely relieved of pain, some days requiring only 1-12 grain of morphine, whereas before the operation he received large and frequent doses of this drug.

The urinary findings and the relation of the urinary output to the blood-pressure are so important that they will be discussed separately at the end of the history.

Dr. Osler saw the patient a second time on January 1 and dictated this note, which is of interest as showing the effect of the operation on the character of the aneurism.

"There is now a very positive murmur heard over a large extent of the infrascapular region. It is loudest below the scar. Pulsation in the front, that is over the aneurism, is not quite as evident as before operation. The tumor is a more definite one. Its upper border is much more evidenced, it is harder, firmer, and not as tender. No thrill. The murmur is very fine. There is a sharp diastolic followed by a sort of venous hum."

Dr. Halsted on December 21 tested the effect upon the aneurism of pressure on the abdominal aorta above its bifurcation. The pressure was sufficient to obliterate the femoral pulse. It produced a well-marked diminution of pulsation in the aneurism. Careful daily measurements were made of the aneurism. There was found to be no increase in its size. It remained harder than before operation, but had always an expansile pulsation.

The patient's pain, previous to the operation, had been too severe and constant to permit his taking a normal amount of food. He had lost 60 pounds in weight. Now, however, he had a good

appetite and ate without ill effects as much as it was thought wise to give him.

The course of the patient continued favorable till January 4, when pain in the region of the aneurism returned. It also radiated to the right iliac fossa. Large doses of morphine were again necessary. The aneurism began to increase in size. It became softer and lost its definite outlines. By January 10 its transverse diameter had become 14 cm. and its vertical diameter 12 cm. A second operation was therefore done in the hope of relieving the pain.

Operation II. Dr. Halsted, January 10, 1907. Partial occlusion of the abdominal aorta with an aluminum band applied between the bifurcation and the inferior mesenteric artery. Ether anæsthesia.

The abdomen was opened by an incision beginning just below the prominence of the aneurism and a little to the left of the umbilicus, and continued down almost to the symphysis pubis. The intestines were retracted to the right side and pushed upward, and the abdominal aorta exposed to the inner side of the descending colon. One or two small vessels in front of the aorta were divided and ligated with fine black silk. The sheath of the aorta was stripped back, and an aneurism needle introduced beneath the aorta from left to right. This ligature about the vessel was used to draw the artery forward and to free it all the way round for a distance of perhaps 2 to 3 cm. Blunt hooks were introduced at each end of this freed portion, and the ligature was removed. A band about 1 cm. broad and 4 cm. long of aluminum No. 29 was now curled with the bandroller about the aorta. It was then rolled with the fingers until it hugged and constricted the aorta, the cylindrical form being well maintained. Even at this first stage of the rolling with the fingers, the pulsation of the aorta did not tend to unroll the band. The band was again tightened, and until the pulse immediately below it could scarcely be obtained with the gloved finger. The pulse, however, could be felt below the band, but was so feeble that it was impossible to count it and it was necessary to palpate the vessel very lightly to order to appreciate the pulse at all. The pulse in the femoral arteries was obliterated entirely.

The abdominal aorta was perhaps only a fourth or a fifth the size of the thoracic aorta as seen at the former operation. The band

was applied at a point about 4 or 5 cm. above the bifurcation and below the inferior mesenteric artery. Fine black silk sutures were used to close the peritoneum. The muscles and posterior sheath of rectus muscles and anterior sheath and the skin were closed with interrupted silver wire sutures.

The patient again made a good recovery from the operation. He complained on regaining consciousness of a coldness and numbness in the legs, but the sensation in them seemed unimpaired. They could be moved at will. Occasionally after the operation, the femoral pulse was felt and even counted, but only under conditions of exertion, excitement, or pain. The wound healed without infection, notwithstanding the leakage of considerable serous fluid from the peritoneal cavity.

On account of the dressing, accurate observation of the aneurism could not be made for a few days.

On January 17, however, the dressing was pulled down and it was noted that the aneurism had increased in size and that it pulsated more strongly than at any previous time since the patient's admission. On this day the patient's blood-pressure reached 145 mm. Pain was severe.

Nothing of importance happened until the twenty-second. On that day the patient complained of a dull ache in the right side of his chest under the clavicle. On the morning of the twenty-third this pain suddenly became very severe and sharp, and localized itself at the upper border of the sternum on the right side. The patient described it as the cutting of a knife. His pulse became very weak. He complained of a choking sensation and spat up great quantities of frothy mucus. On this day a distinct pulsation was made out in the third and fourth interspaces about 4 cm. to the left of the sternum. This had not been noted before. The patient had no inequality of the pupils, no tracheal tug, and his cough was not brassy. There was no perceptible modification of the percussion note over the sternum. In the region of the pulsation no thrill could be felt. The diagnosis of "dilatation of the arch of the aorta" was made. On the twenty-third also, the patient developed dysphagia, which was complete until the time of his death. He was carefully examined by Dr. W. S. Thayer, who concluded that there was a compression of the base of the left lung and probably a thickened pleura in this region, but no fluid. The hæmoglobin at

this time was 65 per cent.; red cells 3,432,000; white cells, 11,140.

An attempt was made on the twenty-fifth to pass a small sized stomach tube. This reached a point 39 cm. from the teeth, beyond which it could not be advanced. Rectal feeding was resorted to.

On January 28, at 7.10 P.M., he cried out with a sudden sharp pain in the left shoulder. The pain got worse and worse and his pulse became rapid and feeble. At nine o'clock he lost consciousness. He was apparently moribund. An intravenous infusion of salt solution was done, which had a remarkable revivifying effect. He sat up in bed, spat out large amounts of white foamy liquid, and began to cry loudly with pain. At 9.52 he died.

Urinary Findings and Blood-pressure.—It has already been mentioned that after the first operation (application of a band to the thoracic aorta) the blood-pressure in two hours was approximately the same in the legs as in the arms. On the day after this operation, December 19, the urinary output was 710 c.c. The urine had a specific gravity of 1034, it contained no albumin, but showed a few waxy casts, which, however, were not observed on any other occasion, although careful examination of the urine was made.

Following the second operation the blood-pressure could never be measured in the legs, for the femoral pulse could only occasionally and then with difficulty be felt. The total daily excretion of urine, and the blood-pressure taken at the same hour each day are charted together in Fig. 2. It will be observed that the total output of urine remained very low until January 19, and, furthermore, that during this period the general blood-pressure, measured at the wrist, rose from 120 mm. to 145 mm. The blood-pressure maintained a comparatively high level until January 22, and during this time the amount of urine was comparatively large. On the twenty-third there was a sudden drop both in the blood-pressure and in the amount of urine excreted.

Unfortunately the voidings for the first two days following the operation were lost, through a mistake of the orderly. They were, however, measured. From this time, however, until the patient's death, a careful examination of a mixed specimen of all the voidings was made daily. A remarkable finding was the enormous quantities of very long waxy casts. These were present until January 20. Many of them measured 1.5 mm. in length. They had ends which presented sharp lines of fracture. Epithelial and granular casts were also present. There was also a trace of albumin. The urine during this time was highly colored and had a tolerably constant specific gravity of about 1030. After the twentieth no casts were found until the day of death, when, after centrifugalization of the urine, a few waxy casts were discovered. It will be noted that the

waxy casts were present during the period of low blood-pressure and diminished urinary flow.

Autopsy No. 2837. E. S., age 36 years. Died 9.52 P.M., Jan. 28, 1907. Autopsy 10 A.M., Jan. 29, 1907. Dr. MacCallum.

Anatomical Diagnosis.—Aneurism of the abdominal aorta; applications of metallic band to constrict the aorta above and below the origin

FIG. 2.

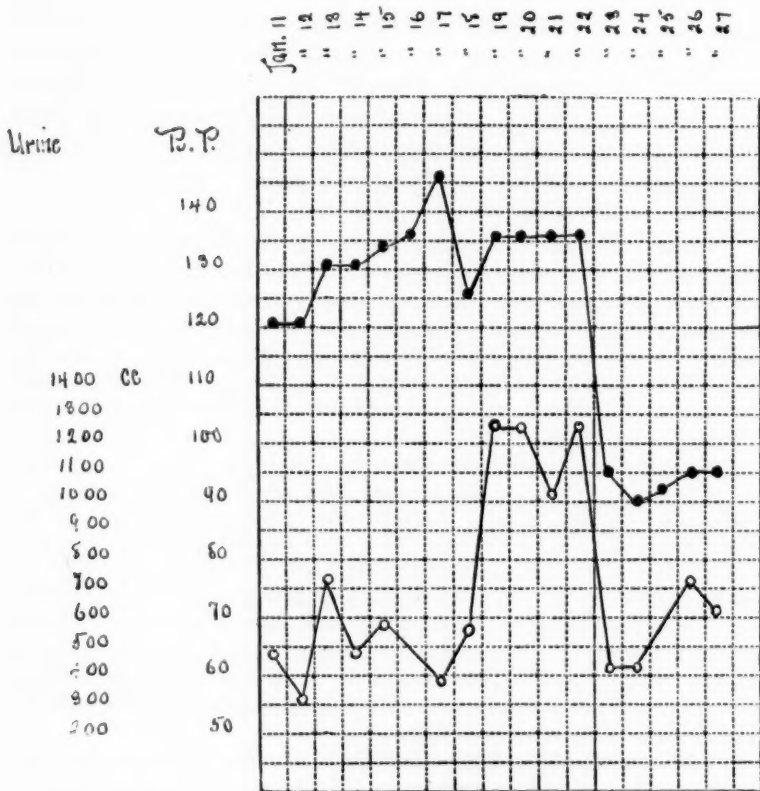


Chart of the daily amount of urine (line with circles) and of the blood-pressure taken daily (line with dots). (Case I.)

of the principal sac; rupture of the aneurism into posterior mediastinum, and into peritoneum; obstruction of the œsophagus; chronic adhesive peritonitis, pleuritis, and pericarditis; thrombosis of two aneurismal sacs; anæmia of the organs; chronic fibrous orchitis, with gumma formation; compression of the lungs.

Body was that of a stoutly-built negro male, 180 cm. in length. Rigor mortis well marked. There was a long scar in the median abdominal line 23 cm. in length. A similar scar 12 cm. in length ran transversely over

the left thorax from the mamillary line to the midaxilla. The pupils were equal, slightly dilated. On attempting to open the abdomen it was found that the intestines were densely adherent to the abdominal wall below the scar, and on cutting through the scar a little pus oozed from the neighborhood of one of the stitches. The peritoneal cavity contained a quantity of bloody fluid. This fluid was not like pure blood, but it seemed to have resulted from the admixture of blood with ascitic fluid. The intestines were everywhere adherent to one another. Over the stomach, between it and the diaphragm, there was a large blood-clot which seemed perfectly fresh. The diaphragm reached the fourth rib on the right side, fifth rib on the left side. The pleural cavities were obliterated by old adhesions. There was no accumulation of fluid anywhere within the thorax. The pericardial cavity was completely obliterated by adhesions, which were loose and easily displaced.

Heart was not enlarged. The cavities contained only fluid blood and post-mortem clots. The endocardium was everywhere smooth. The valves were all delicate and competent. The coronary arteries were slightly thickened. The heart muscle was soft, grayish, and opaque, and very pale.

Lungs: The left lung was tightly bound to the costal pleura and to the pericardium, and could be removed only by tearing through the adhesions. It was not enlarged. On section the bronchi and blood-vessels and bronchial glands were normal. The substance of the lung was for the most part air containing but there were considerable areas of atelectasis. The same description will apply fairly well to the right lung, which was, however, more voluminous and showed fewer areas of collapse. There was no consolidation in either lung.

Spleen weighed 100 mm. It was densely adherent to the surrounding tissues. Its capsule was thickened and dense about the points of adhesions. On section it was very pale, soft, and pasty. The splenic pulp was grayish red in color. The Malpighian bodies and trabeculae were readily seen.

Stomach and duodenum were normal.

Liver measured 33 x 19 x 9 cm. Was rather soft. There was great elongation of the left lobe which extended far upward over the stomach. The liver was smooth superficially, rather flabby and soft. Section showed the lobulation to be uniform and distinct. The centres of the lobules were quite dark, red, often with an opaque yellow spot, while the peripheral portions were yellowish gray. The gall-bladder was distended with very dark bile. Its walls were normal.

Pancreas and duodenum were flattened out over a projecting mass in the median line, which was as large as two fists. The pancreas was firm and normal in appearance, but rather large. In the anterior portion of this sac-like mass there was a hole with ragged outline, about 1 cm. in diameter, through which a probe passed deeply into the cavity of the mass. Through this hole the blood had exuded into the peritoneum.

Kidneys were about alike, they were large and measured 13 x 6.5 x 1.5 cm. The capsule stripped with some difficulty, splitting a good deal, but

finally left a fairly smooth surface. On section the cortex was about 7 or 8 mm. in thickness. Its striations were regular and normal in appearance. The right kidney was especially lobulated.

Adrenals were normal.

Bladder and rectum, normal.

Thyroid was normal in appearance, although the left lobe was very small.

Parathyroids were extremely pale, whitish yellow, but normal in consistency.

Testicles were very large, and showed adhesions to the tunica vaginalis so that they could not be stripped free. On section the brownish substance of the testicles was replaced over large patches by pearly white tissue. This was true throughout both testicles. The left contained a nodule, the marginal portion of which was of dense scar tissue, grayish, while the central part was more opaque and brown in color. This nodule measured about 6 mm. in diameter, the scar tissue radiated from it into the surrounding tissue.

Aorta: After removing all the viscera described, it was found that there was a mass about 15 x 6 x 6 cm. in the neighborhood of the oesophagus, just above the diaphragm and extending chiefly toward the right. A large bougie passed down the oesophagus into the stomach met with a marked obstruction. At a point about 6 cm. above the diaphragm this was passed with a jerk and the bougie passed into the stomach. The finger passed into the oesophagus, reached the ridge projecting from the right side and narrowing the oesophagus. Just below this a metal ring was felt about the aorta, and at a point about 4 cm. above the vault of diaphragm. A similar ring was just above the bifurcation of the aorta, and about the latter there was a great deal of radiating scar tissue. The whole aorta was removed and opened from behind. The iliac arteries were practically normal in appearance. Just above the bifurcation, the aorta was constricted by the aluminum ring to a diameter of about 4 mm., which just allowed a large probe to pass. No very distinct collateral dilatation of arteries was observed. About 2 cm. above the openings of the renal arteries there was a hole in the anterior wall of the aorta, about 4.5 cm. long and 3 cm. wide, which opened suddenly into a large sac. The aorta in general was not sclerotic. There were no patches or roughening, but although somewhat blood stained, its lining membrane was fairly smooth. At the margin of the hole there was absolutely no alteration of the vessel wall, and the orifice of the sac looked as if punched out. The sac projected directly forward, pushing aside the abdominal viscera as described. It was large enough to contain about 800 cc. of fluid, and was partly filled by a laminated thrombus mass as mentioned above. There was a ragged hole in its extreme anterior wall, which allowed the escape of blood. The coeliac axis and superior mesenteric artery opened off the front wall of this sac, so that the orifice of the sac occupied the position from which they should have originated. The sac wall was rather thin, inelastic, and fibrous, but not greatly roughened. The sac extended up behind the stomach, and to the right of the oesophagus, against the diaphragm, which it eroded. A

FIG. 3.



Photograph of the specimen. The aorta has been laid open, and is viewed from behind. The probes are in the iliac arteries. The upper band has been cut across and opened; the lower band is intact. The lining of the aorta is smooth and normal in appearance. The openings into both aneurysms can be seen. (Case I.)

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perforation had taken place through the diaphragm into the tissues to the right of the œsophagus, and an extensive hemorrhage had occurred into these tissues, so that a large cavity had formed in the posterior mediastinal tissue along side of the œsophagus, and was filled with blood-clot which caused the compression of the œsophagus and the inability to swallow. Above the diaphragm about 4 cm. the aorta was again narrowed by the upper aluminum band, to such a degree as only to admit the tip of the little finger. The band was cut through and spread open, but there was no alteration of the vessel wall visible to the naked eye. The band was healed into a mass of fibrous tissue. Springing from the arch of the aorta there was a second aneurism which projected upward in a symmetrical way from the arch. It was about 5 cm. in diameter, and rounded, and did not compress the œsophagus or trachea. From it the left carotid, subclavian, and the innominate arteries sprang. The aorta round about it was not markedly sclerotic and its own walls, though fibrous and inelastic, were not very much roughened. They were covered in part with a laminated thrombus.

Brain showed no abnormality externally, except a few pin-head sized opacities in the somewhat thickened pia.

Intestines, although adherent to one another, were normal throughout as far as their mucosa was concerned.

Larynx: From between the true and false vocal cords there projected a small pedunculated mass of soft œdematous tissue. This measured about 4 mm. in diameter.

Microscopical Notes.—Parathyroid showed the palisade arrangement of the marginal cells. Most of the cells had the finely granular character. There were a good many eosinophiles.

Spleen: The splenic capsule was enormously thickened and fibrous, and showed hardly any cells.

Larynx: One section passed through a small mass of tissue, which was composed of œdematous fibrous tissue, containing mucus secreting glands, and covered with columnar epithelium. This was apparently the nodule seen rising from the vocal cord in the larynx.

Kidney: Microscopical sections of the kidney showed the capsule still in place. The cortex was not particularly distorted, although there were no distinct scars. The glomeruli were normal. The capillaries throughout the kidney were fairly well filled with blood. The epithelium of the tubules was everywhere more or less degenerated. This was especially true of the convoluted tubules in the cortex. The cells were frequently detached from the walls of the tubules and were very ragged and granular. In places they formed mere masses of dislocated cells in the centers of the tubules. Most of these dislocated cells had deeply staining shrunken nuclei while others formed merely a ragged débris. All of the tubules were found to contain a granular and bubble-like material which is frequently seen in various forms of nephritis, and which was apparently coagulated fluid. The vesicle or bubble-like structures which make up this fluid were often found to be in intimate relationship with the epithelial cells. There was no infiltrating exudate of any sort. The cells did not appear to have

accumulated fat globules to any extent. No casts were seen in the tubules even far down in the medulla, except in two tubules where distinct deeply staining casts were seen. These were quite near the papilla. There was no marked œdema of the kidneys, but from the shrinking and desquamation of the cells the whole cortical portion had a rarefied appearance.

Thyroid: The stroma was quite abundant and dense. The alveoli were filled with homogeneous colloid. They were lined uniformly with cubical epithelium.

Testicle showed an extreme degree of fibrous orchitis. The tubules were completely obliterated through most of the section. At the central part there was a scarred area which was pigmented very much.

Liver showed an exquisite chronic passive congestion. Some of the congested areas still showed the remains of necrotic cells.

Pancreas was very œdematous. The elements were spread widely apart, but they were otherwise normal.

Heart: The pericardium was obliterated by loose connective-tissue adhesions. No remnants of the cavity or of the epithelium were left. The heart muscle was practically normal.

Aorta: A section passing through the edge of the aneurism of the arch of the aorta showed a sudden break in the media. The fragment of the media was continued into the wall of the aneurism, but separated from the rest by a cavity which was filled with fluid. A great deal of irregularly arranged scar tissue was heaped around this point of fracture. The intima was enormously thickened. On passing into the sac proper it was no longer possible to distinguish the layers. The wall was made up merely of dense fibrous tissue.

CASE II (Surg. No. 23652).—S. M. O., white, age fifty-three, was admitted to the service of Professor Halsted in the Johns Hopkins Hospital on February 9, 1909.

Complaint.—Colic-like pain in the abdomen between the navel and the stomach, inability to digest food, chronic constipation, and great loss in weight and strength.

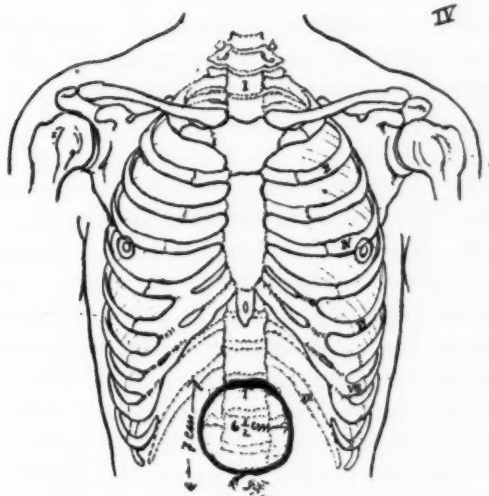
Family and Personal History.—Patient had never had any diseases of importance except malaria and dysentery. He had suffered with chronic gastro-intestinal trouble for years. In 1899 he was operated upon for hemorrhoids. This operation caused a slight thread-like stricture of the rectum which had been dilated digitally several times. Denied having syphilis; Wassermann reaction negative. Was a moderate drinker, and used tobacco to excess.

Present Illness.—The time of origin of the aneurism is uncertain, as the symptoms therefrom were attributed to the patient's chronic constipation. He had noticed an epigastric tumor for six or eight months. This was regarded by himself and his

physicians as a fecal impaction, and this diagnosis seemed to them to be confirmed by its decrease in size after cathartics and enemata. Pain had been the dominating symptom. This was localized above the navel and in the region of the right kidney. It was made worse by exercise and relieved by lying down. He described it as colic-like, this idea of its character being suggested by its supposed relation to the intestinal trouble. The pain required large doses of morphia, and finally led him to consult Dr. Halsted. His weight had decreased from 190 to 118 pounds.

Physical Examination.—The patient was of large frame but

FIG. 4.



The aneurism and its relations. (Case II.)

greatly emaciated. He had emphysema of the lungs and a slight bronchitis. His peripheral arteries were sclerotic. These were the only findings of importance except the abdominal tumor. The abdomen was scaphoidal in shape. Its walls moved freely with respiration. No tumor was visible, but marked pulsation could be seen extending from the umbilicus to the xiphoid cartilage. On palpation a tumor could be felt immediately above the navel. This was spheroidal in shape, and was situated somewhat more to the right than to the left of the midline. It could be grasped between the hands, and had a definite expansile pulsation. It did not descend on inspiration. Its right lower quadrant was firmer

than the rest of the tumor, and formed a boss-like prominence, which was very tender. No thrill nor shock could be felt. The vertical diameter of the tumor was 6.5 cm.; the transverse, 7 cm. Between the tumor and the abdominal wall a strip of bowel could be palpated.

The findings on percussion were unimportant. On auscultation a systolic murmur could be heard over the tumor and downward along the aorta and the iliac arteries, but not over the femorals.

Operation I. February 23, 1909, Dr. Halsted; ether anæsthesia. Application of a metal band to the abdominal aorta immediately above the renal arteries.

The following description is a quotation from the notes made by Dr. Halsted a few hours after the operation.

"A long incision from the ensiform cartilage to the lower border of the umbilicus was made through both the anterior and posterior sheaths of the left rectus abdominis muscle, the muscle being split near its inner edge. This incision was made in preference to one in the midline to facilitate stitching and to strengthen the wound. The liver was found to be low, its lower edge in the midline, slightly overlapping the aneurism. The operating board being raised high at the foot, the liver and stomach dropped back into place. In operations upon the abdominal aorta of dogs, it was found very advantageous to tilt the operating board steeply in such manner. The transverse colon was packed upwards, the small intestines and the ascending colon to the right, the sigmoid flexure to the left. The mesenteric fat on the colon was quite dense, being more or less matted to the aneurism. Large veins occupied this fat, and one of these, presumably the inferior mesenteric, was so directly in front of the aorta just above the aneurism and at the point of election for the band, that at first it was difficult to retract it sufficiently to make access to the artery at this point feasible. The pancreas was slightly adherent to the aneurism above and hence I attempted at first to expose the aorta above the pancreas. Such a plexus of veins presented themselves at this situation that I decided once more to try to separate the pancreas from the aneurism. This was accomplished with less difficulty than I had anticipated. At the site elected for exposure of the aorta, the inferior mesenteric vein, the vena cava and the left renal vein were in contact with

each other. Separating them in gridiron fashion, we soon found ourselves in a very deep hole, circumscribed by such large and important vessels that the operating field in its deepest portions could not well be enlarged. These vessels overlapped the upper edge of the aneurism and were put on the stretch by it. Immediately above the aneurism was the left renal vein, flattened from before backwards, and measuring from above downwards about 1.5 to 1.8 cm. From this renal vein at its upper edge and immediately over the middle of the aorta was given off a large vein, which may have been the left inferior phrenic but which did not run directly upwards, its direction being somewhat outwards as well as upwards. This ascending branch of the left renal vein hampered us so much that we finally divided it and then were able to expose at this point the abdominal aorta, but only by retracting downwards with a vein retractor and with some little force the left renal vein. The superior mesenteric artery was not clearly defined in the dissection, but a resistance was experienced to the exposure of the anterior surface of the abdominal aorta to a point higher than perhaps 2 cm. above the upper edge of the left renal vein (before the latter was retracted).

"In attempting to free the aorta we were compelled, therefore, to confine our operations to the immediate neighborhood of the aneurism in the little space between the superior mesenteric artery and the left renal vein which latter was firmly retracted downwards. The freeing of the artery was, therefore, difficult because of the restricted space, the great depth of the aorta, and the large amount of new connective tissue which was formed in the vicinity of the aneurism. The upper surface of the aneurism presented an almost vertical wall about 5 cm. deep, at the foot of which was the aorta. The freeing of the aorta at this great depth and through the gridiron opening bounded by the veins enumerated was accomplished with long, narrow dissectors especially constructed for work in deep confined spaces. These long, delicate instruments proved of great value, for the space in which we were compelled to work would, for a considerable time, hardly admit one finger. Finally the artery was satisfactorily circumscribed, and two tape ligatures passed about it from right to left by means of aneurism needles. After the passage

of these ligatures we endeavored by their aid to expose more of the artery in order to make space for the metal band. The renal arteries prevented dissection downward, and lumbar arteries were encountered above, removed probably not more than 1.5 cm, from the renals. The vena cava, which overlapped the aorta slightly, was at an earlier stage of the operation easily separated from it.

"The depth of the aorta was now so great and the field of operation at its deepest portion so restricted that I feared it might not be feasible to introduce a straight instrument of the width of a bandroller (about 9 mm.) under this vessel. The space was too small to admit of the introduction of two gloved fingers. Removing the glove of the left hand, I palpated very carefully the wall of the aorta at its exposed portion to determine if it would be safe to make considerable traction upon it forwards with the underlying tapes. As there seemed to be no evidence of calcareous degeneration, sufficient traction was made with the tapes to occlude the aorta and greatly reduce it in size. A very carefully filed band (about 5.5 mm. in width, approximately 5 cm. long, and of thickness No. 25 of the American scale), was placed in the instrument, and the piston of the instrument pushed forwards until about 4 mm. of the rounded end of the band was exposed at its tip. The loaded instrument was then passed under the aorta until the tip of the band could be seen. The piston being then pushed home and the tapes still drawn upon to occlude the lumen of the aorta, the band was made to encircle the vessel satisfactorily. It was then tightened by rolling with two fingers to the degree desired. The lumen of the aorta was very considerably occluded, as evidenced by the great bulging of the portion above the band, by the softening of the aneurism, and by a thrill which before had not been perceptible. I should think that the lumen was lessened by approximately $\frac{3}{4}$; in other words, reduced to $\frac{1}{4}$ or $\frac{1}{5}$ of its original size.

"A thrill, well pronounced, could then for the first time be felt in the aneurism. The pulse in the left femoral artery was almost obliterated, but could in a few moments be distinctly felt, and was at no time uncountable. The peritoneum with the posterior layer of the sheath of the rectus muscle was closed with No. 1 catgut; the anterior sheath of the muscle with a continuous suture of No. 2 catgut, doubled; the deep subcutaneous fascia with a continuous suture of fine silk. Two sutures of silver wire

were taken through the anterior sheath of the rectus in support of the catgut. These did not penetrate the skin. The skin was brought together in the lower half of the incision, where there was tension, with silver wire; in the upper half, where there was none, with fine black silk.

"From the beginning of the operation to the completion of the rolling of the band two hours were consumed; probably $1\frac{1}{2}$ hours of this time were required for the adequate exposure of the aorta. The operation was one of the most difficult that I have performed. Had it been possible to apply the band below the renals, it would have been tightened until the obliteration of the

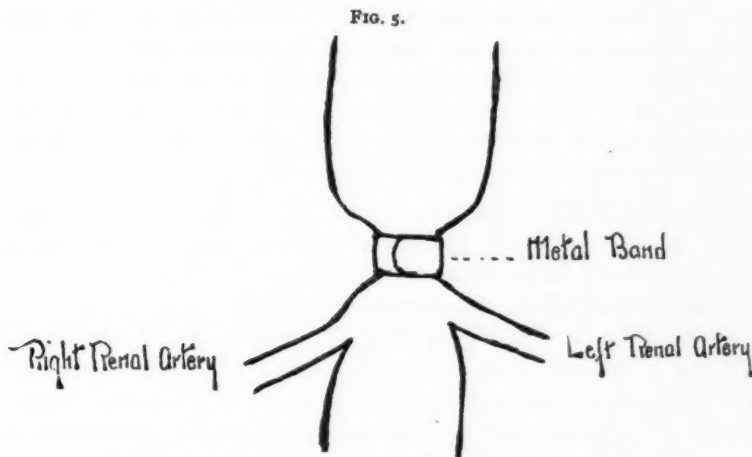


Diagram showing degree of constriction by the band. (Case II.)

femoral pulses was complete and until the pulse below the band was barely demonstrable."

The degree of constriction of the aorta is shown in Fig. 5. The femoral pulse was never entirely obliterated, though for a time it could not be counted.

The wound in the abdominal wall was carefully closed in layers.

The patient made an excellent recovery from the operation. The wound healed per primam. The following note made by Dr. Halsted on March 1, the beginning of the sixth day after the operation, describes the striking change in the aneurism:

"We were surprised to find that the pulsation over the

aneurism is so greatly lessened in force, even after prolonged coughing fits. Indeed, to the right of the scar there is little to indicate the presence of an aneurism, except on deep pressure. Pulsation is most distinct in the concavity just below the aneurism, to the left of the scar. On palpation, no thrill is to be felt either over the scar of the aneurism, or elsewhere in the course of the arteries. One has the general impression that the aneurism is greatly diminished in size."

The character of the patient's pain had changed completely since the operation. He now had a dull continuous ache in the left upper quadrant of the abdomen. The pain was quite bearable, and required but little morphia for its relief.

There was a steady improvement until March 6, when suddenly the patient had a chill, developed a temperature of 103° and had sharp pain in the appendix region. From now on until March 23 he had a daily rise to 102° or 103° . The aneurism began rapidly to increase in size. It became tender and pulsated again forcibly; the cystolic murmur over it, which had practically disappeared, returned. On March 7 the aneurism measured 8.1 cm. vertically and 10 cm. transversely. The patient again required large doses of morphia. Dr. Finney was now called in consultation, and advised wiring of the aneurism.

Operation II. March 12, 1909, Dr. Finney. Ether anæsthesia. Wiring of the aneurism. A small incision was made to the left of the previous scar over the most prominent part of the aneurism. On opening the peritoneum the aneurism presented at once, being covered only by a thin peritoneal coat, containing large blood-vessels, probably the transverse mesocolon. The needle was inserted into the sac through the peritoneum in the space between several of the large mesenteric vessels and eleven feet of wire were passed into the sac through the needle. Ten amperes of current were now passed through the wire for 40 minutes, then 20 amperes for 10 minutes, and then 40 amperes for 10 minutes. After this, the needle was withdrawn, the wire *inverted* and turned into the sac. Bleeding, however, was quite profuse from the puncture wound in the sac and required three Lembert sutures of fine silk to control it. The abdomen was closed in layers. The patient again made a good operative recovery, but the pulsation and growth of the aneurism was apparently but little affected by the wiring. On March 21 it was

observed to have increased rapidly in size and to have grown downward into the right iliac fossa and also downward below the navel. At this time the blood-pressure in the right leg was found to be only 118 mm., whereas in the left leg it was 155 mm. This was interpreted to mean that the aneurism was pressing on the right iliac artery.

The pulsating mass was very superficial and very sensitive to pressure. It looked as if it were pointing and about to rupture at a point just to the right of the umbilicus. The aneurism measured 15 cm. transversely and 12 cm. vertically.

The patient's course from this time until his death was steadily downward and without incident of special importance. Unable to take food, his emaciation became extreme. April 9 he died.

Blood-pressure and Urinary Findings.—Before the first operation, the patient's general blood-pressure, measured in the right radial, was 150 mm. His urine contained a few granular casts and a trace of albumin. The chart (Fig. 6) shows the drop in the blood-pressure of the lower extremities which occurred on application of the band and also the comparatively rapid return of a palpable pulse in the dorsalis pedis artery. Unfortunately daily observations of the blood-pressure, *were not* obtained, so that our records are somewhat deficient in this respect. On February 25, however, the blood-pressure in the arm was found to have risen to 190 mm., while that in the legs was 180 mm. On March 6 the blood-pressure had dropped to 130 mm. in the arm. On March 15 it had risen to 170 mm., and just before death it was 110 mm. The pressure was practically the same in the arm and leg, but, as has already been mentioned, it was different in the two legs. Owing to the lack of daily observation, we could not establish so clear a relation between the blood-pressure and the urinary output as in the other case. On the day following the operation, the amount was 600 c.c. On the next day it was 1100 c.c. The amount seemed to depend entirely upon the quantity of liquid ingested. The urine was always of a normal specific gravity. As in the other case, a shower of waxy casts appeared in the urine after the application of the band. These decreased in numbers after the first few days, but a few could always be found.

Autopsy by Dr. W. G. McCallum, 9 A.M., April 15, 1909. Surg. No. 23652, S.M.O., age 53 years. Autopsy No. 3202.

Anatomical Diagnosis.—Extreme arteriosclerosis; aneurism of abdominal aorta just below the renal arteries; operation for application of metal band above the renal arteries; second operation for wiring of aneurism; occlusion of aneurismal sac by thrombus; infection of tissue about the band; extensive abscess formation in psoas muscle; compression of pylorus and duodenum; partial obstruction by compression of common bile-duct and pancreatic duct; distension of gall-bladder; dilatation of pancreatic duct; atrophy of pancreas; compression of right renal artery;

compression of inferior vena cava below right renal vein; complete thrombosis of vena cava and branches up to the right renal vein; anaemia; atrophy of right kidney; phleboliths in spleen, kidney, and liver; emphysema of lungs; extreme emaciation.

The body was that of an extremely emaciated old man, 175 cm. in length. There was a small decubitus ulcer over the sacrum. In the mid-line of the abdomen there was a long linear scar. A little to the left of this there was a shorter scar which was also linear in shape and per-

FIG. 6.

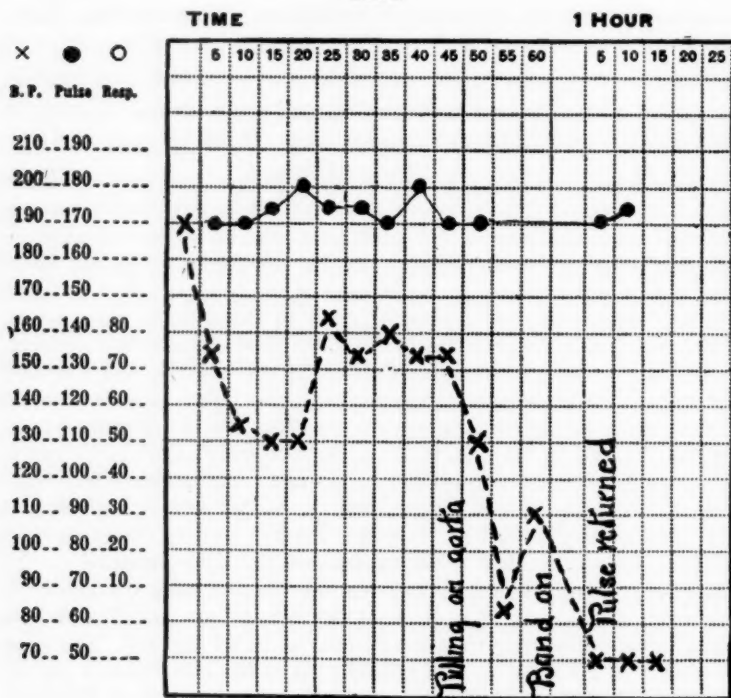


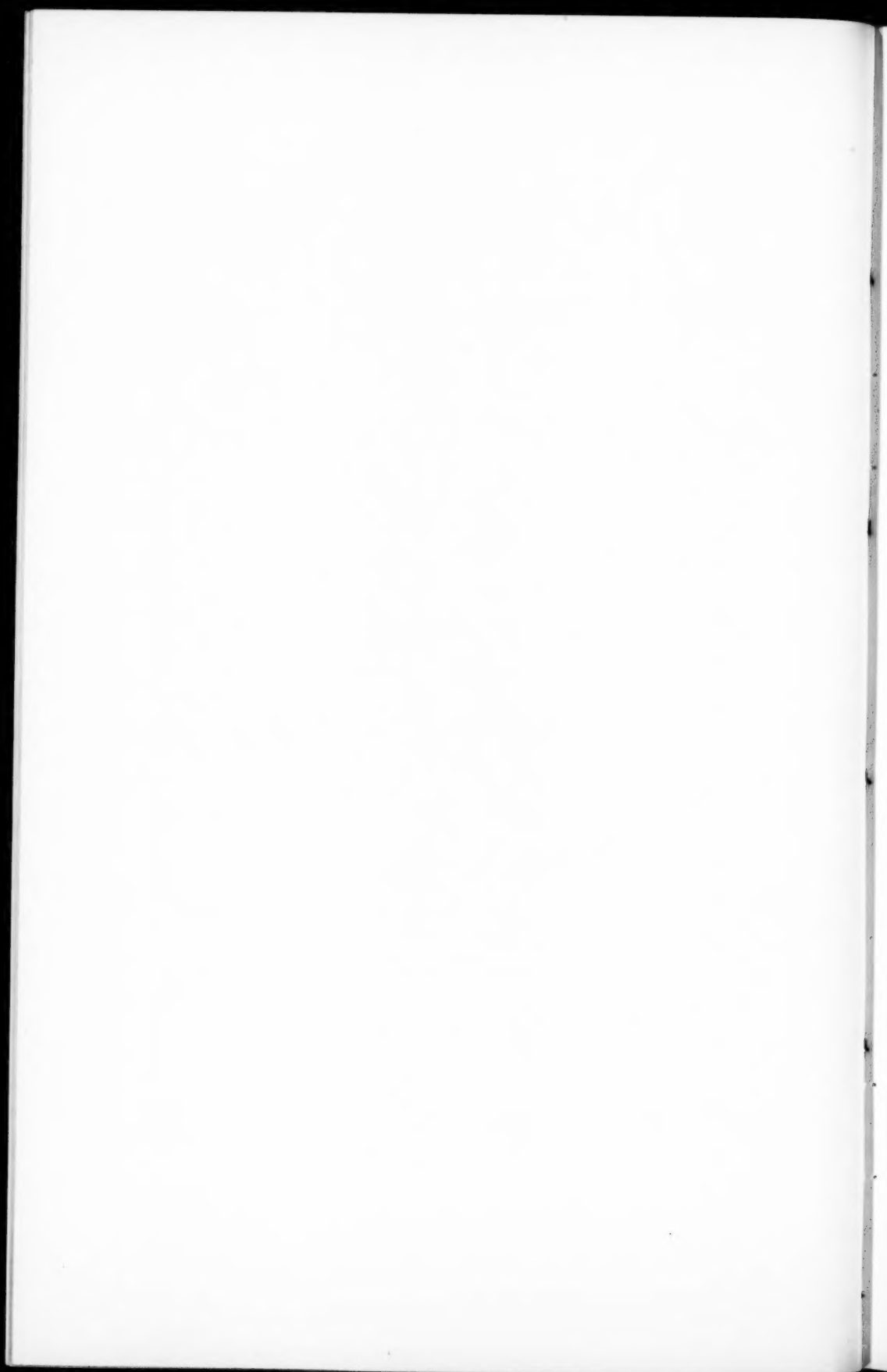
Chart of the pulse and of the blood-pressure (taken in the dorsalis pedis artery) during the operation. (Case II.)

fectly healed. In the midline just above and about the umbilicus there projected a large, rounded mass about 15 cm. in diameter. On opening the abdominal cavity, the peritoneum was found to be adherent to this mass. The peritoneal cavity was dry. The intestines were collapsed and lay far down within the pelvis. The transverse colon lay just above the tumor mass and was not especially adherent to it, but was attached rather loosely to its mesentery. The stomach was small. It was stretched up over the upper surface of the mass so as to arch above it. The duodenum encircled the projecting mass and was apparently somewhat compressed by it. The pylorus lay directly at the upper pole of the tumor. Between

FIG. 7.



The interior of the aorta seen from behind. A probe in the left renal artery. The band is immediately above it; the opening into the aneurism immediately below the artery. The aorta shows an extreme degree of degeneration. (Case II.)



the tumor and the liver there was a great band of tissue that held the enormously dilated common bile duct with the portal vein and the hepatic artery. The gall-bladder was greatly distended. Bile could be squeezed through the very much flattened duct, which lay stretched over the surface of the tumor. Just above the tumor mass the common duct widened out to a circumference of about 3 cm. The cystic duct was greatly dilated, and the gall-bladder greatly enlarged. It was 12 cm. in length. The pancreas was flattened out over the surface of the projecting mass. Its surface was nodular and rough. The pancreatic duct opened freely at its papilla side by side with the bile-duct. It was, however, somewhat flattened out by being stretched over the surface of the tumor. On following it back to a point where it was no longer stretched by the pressure, it was greatly dilated and filled with a turbid grayish fluid. It measured about 2 cm. in circumference. The pancreas was somewhat atrophied about this dilated duct, and formed merely a wall which was about 5 cm. in thickness.

The heart, stomach, œsophagus, aorta and kidneys were removed in one mass and dissected afterwards. It was found that the mucosa of the duodenum was not particularly abnormal. That of the stomach was hyperæmic with some hemorrhages and a few minute erosions. The œsophagus was normal. On removing the aorta and kidneys a fluctant mass was found occupying the position of the right psoas muscle. When cut into, this was found to be composed of a large sac filled with reddish gray, thin purulent fluid. The finger passed up in this cavity quite far behind the right kidney and against the second, third, and fourth lumbar vertebræ. An attempt to remove the aorta from the vertebræ revealed an infiltrated condition of the tissues in front of the vertebræ. They were not, however, eroded of their actual bony substance. The back of the aneurismal sac lay directly upon the abscess cavity in the psoas muscle, and the remaining tissue of the psoas muscle was not sufficient to separate it completely from the abscess cavity, so that apparently this abscess cavity was partly covered in front by the back of the aneurismal sac. Further inspection of the back of this aneurismal sac showed that canals full of purulent material burrowed about in its surface and extended upward towards the aluminum band which was put on at operation just above the renal arteries. The aneurismal sac, however, was not actually opened in being removed, but, found in contact with the vertebral column, its wall was so thin as to be very readily torn through—in fact so thin as to be only with the greatest difficulty maintained intact. Wire was felt projecting from the sac up against this extremely attenuated wall. The aorta was then opened from the back, and it was found that there was a large opening immediately below the renal arteries extending to a point 5.5 cm. above the bifurcation. The opening measured 4 cm. vertically and 3 cm. in transverse diameter. It was quite clear cut. The aortic wall turned over into this aneurismal sac, but became greatly altered after a short distance. The sac itself extended quite far about and below this opening, so that it overlapped the bifurcation of the aorta and extended at least 3 cm. above the orifice of the renal artery. The right renal artery was

stretched out over the top of the sac. The left renal artery was not particularly altered. The aluminum band, which was 9 mm. wide, had been put on just above the renal arteries, not more than 3 mm. above the right renal artery. It was situated just below the superior mesenteric artery, missing it by 5 mm. It had caused a marked constriction which did not admit the tip of a little finger and had healed quite well. It lay in a little cavity in the tissue which apparently communicated with the pus containing canals described above. There was also some blood in this space, and when the constricted area was cut through, it was found that there was a tiny hole in the back wall of the aorta through which the bone was visible. Evidently the constriction was sufficient to keep the blood from escaping. The wall of the aorta at this point seemed to be in part cut through. The intima appeared to be intact, but the media seemed to be completely eroded away by the band. Above and below the band, the aorta was extremely sclerotic and very much deformed. There were various patches which were quite translucent, and were extremely soft and gelatinous as if filled with fluid, while in other areas there was a distinct deep erosion. The ragged edges of the ulcers were covered with soft debris. Elsewhere the wall of the aorta was very irregularly studded with thickened patches. The arch of the aorta was also sclerotic. Below the opening of the aneurismal sac there were also extensive patches of sclerosis and some calcification just at the bifurcation. When the sac itself was cut through, it was found that the lumen was almost completely obliterated by a firm, spongy clot through which the wire extended in every direction. Anteriorly the wall of the sac was fairly thick, but posteriorly it was very much thinned out. The inferior vena cava was completely thrombosed up to the level of the right renal vein, which was enormously distended. Above that the vein was open. It was much compressed and flattened by the pressure of the aneurismal sac. The portal vein was not especially affected. The aneurismal sac measured about 11 cm. in vertical diameter, by 8 cm. in anteroposterior diameter.

Kidneys: The left kidney measured 11 x 5.5 x 4.5 cm. Its capsule stripped off smoothly, leaving a reddish gray surface, somewhat deeply lobulated. The cortex measured 5 mm. in thickness. Its striations were rather indistinct. The kidney had a rather translucent appearance, mottled grayish dark red. The right kidney was smaller, measuring 10.5 x 5.5 x 3.5 cm. Its capsule also stripped off fairly smoothly. The kidney was more anæmic than the other kidney. In places the cortical surface seemed to be especially atrophic and thinned out. At one point there was an irregular, reddish patch with opaque yellow spots in its central part which extended deep into the substance of the kidney, and in which the striations and general markings of the kidney were lost. In the thinner parts of the cortex this was true also.

Heart: The pericardial cavity contained no excess of fluid. Its surfaces were quite smooth. There was a curious watery atrophy of the sac. The heart was small. The coronary vessels upon the surface were sclerotic and tortuous. The valves were delicate throughout. The heart muscle was quite soft and mushy, of a reddish brown color.

Lungs were enormously distended with air and extremely cushiony. They were smooth superficially and quite uniformly distended. They were very dry and pale on section.

Spleen: Similar nodules to the ones in the liver were seen on the surface of the spleen. It measured $15 \times 7 \times 4.5$ cm. It was fairly firm. On section the splenic substance was dark red. The Malpighian bodies were inconspicuous, and small yellowish white nodules were found scattered throughout.

Liver was not enlarged, measuring $24 \times 19 \times 9$ cm. The surface was smooth. It was dark grayish red in color. The bile-ducts were greatly distended throughout the whole liver. Many of them contained soft, granular concretions. The liver was not bile stained in general, but slightly so about the bile-ducts. The lobules were extremely small and indistinct, rather homogeneous, grayish red in color. The liver contained a number of small semitranslucent nodules about 2 to 3 mm. in diameter.

Bladder (urinary) contained a little turbid urine. Prostate was not enlarged. The mucosa of the bladder showed some hemorrhages and a great deal of hyperæmia. There was no ulceration or very distinct evidence of infection. The mucosa of the rectum was congested in certain areas. No very distinct scars could be made out in any part.

Intestines were deeply injected through the lower portion. The colon was injected in patches and at one point there was to be seen a small polypoid elevation, but there was no ulceration of the intestinal mucosa.

Microscopical Notes.—Kidney: In the surface of the cortex of the left kidney at one point there was a small, necrotic, fibrous mass which was surrounded by granulation tissue, in which giant-cells occurred. The cortex of the kidney was somewhat distorted by the presence of the scars which ran irregularly through it. It showed numerous obliterated glomeruli and many shrunken tubules, but there were patches here and there in which the tubules showed apparently compensatory hypertrophy. The whole picture was that of chronic diffuse nephritis. The glomeruli for the most part were pretty well preserved. The tubular epithelium was very well preserved in the tubules which were still extant, but the tubules were filled with this same granular, vesicular material that was so commonly seen in them. There were a few casts in the cortical portion and very little desquamation of epithelium. There were some small cyst-like structures in the cortex which were filled with colloid material. These were apparently glomerular capsules in which the tuft sometimes appeared flattened out against one side, in other cases it did not appear at all. Even in the papillary portion of the kidney there were extremely few casts. Those that were found, however, were dense in appearance, and contained much cellular débris. Section of the right kidney showed extraordinary concentration of the glomeruli which seemed to lie embedded in a dense fibrous tissue containing hardly any tubules. Here and there, however, there were patches in which the tubules were grouped together. The kidney did not contain many casts, but there were a few in the pyramidal portion. These were hyaline in character. The epithelial structures were

pretty well preserved as far as any recent changes were concerned, but of course the enormous atrophy existed as a result of a long continued pressure. Another section of the same kidney showed numerous areas in which there was an abundant round-cell infiltration and an infiltration with polymorphonuclear leucocytes. These areas had almost the appearance of abscesses in places. A good many bacteria could be seen in the kidney also, especially in the areas where the tubules were filled with leucocytes. The greater part of the kidney, however, was shrunken and fibrous. In the pyramidal portion in this section there were numerous casts of a hyaline character.

Lung showed advanced emphysema.

Aorta: The gelatinous plaques found in the aorta were composed of necrotic material full of cholesterin crystals representing exaggerated examples of the ordinary type of arteriosclerosis.

Pancreas showed atrophy of its substance so that the lobulation was very much accentuated. It showed, however, much more than this. There was an infectious process going on throughout the pancreas which produced extremely interesting changes. All of the ducts of the pancreas were infiltrated with leucocytes. They were almost collapsed by the invasion of the leucocytes outside the epithelium. The whole pancreas was thickly infiltrated with leucocytes which here and there formed accumulations which looked almost like abscesses. The process, however, was very diffuse. The islands of Langerhans were at least free, and in fact were generally free from any infiltration. Another section of the pancreas showed a very similar change. This section was apparently taken quite far out. In the portion of the pancreas right over the aneurismal sac was very marked compression, but the infectious process was not so distinct.

The aorta just at the point of application of the band showed as elsewhere marked arteriosclerosis. The media, which was pretty well preserved and infiltrated with leucocytes, suddenly became necrotic, and exactly through the region of the compression by the band it was completely devoid of nuclei. On either side it was well preserved. The intima in its innermost layers showed nuclei all the way across, but many of these were fragmented. There were some hemorrhages and a great deal of leucocytic infiltration in the tissues about the area.

Liver showed no marked changes except what might be a senile atrophy. There were a few small scars. In one place there was a necrotic nodule surrounded by fibrous tissue. Section through the femoral vein showed a beautiful organizing thrombus.

REMARKS UPON CASE I.—The patient survived the first operation forty-one days, and the second eighteen days. The first operation checked for a time the growth of the aneurism and relieved the patient's pain. The benefit of the second operation was problematical. It was performed because the patient's condition was becoming less favorable.

The blood-pressure in the legs quickly rose to its normal level after the application of the upper thoracic band. The aneurism probably received most of its blood supply from below. This view is supported by the fact that there was diminution in the force of the pulsation in the aneurism when pressure was made on the aorta just above its bifurcation, and also by the considerable disturbance of the urinary secretion which occurred after the application of the second band.

There was no impairment of sensation and no demonstrable loss of muscular power, though the aorta had been constricted both above the diaphragm and at its bifurcation. Obviously tests of the patient's ability to walk could not be made.

We have noted that the second band diminished the blood supply to the kidneys. That after a time the circulation was properly re-established is made probable by the fact that the urine became normal in amount and in quality. The return to normal was coincident with a rise in the central blood-pressure, which rise may have been due in part to the disturbance of renal function and in part to the constriction of the aorta. Katzenstein and Offergeld have shown that ligation of the aorta, even below the renal arteries, causes a rise of blood-pressure.

REMARKS UPON CASE II.—The patient lived forty-five days after the application of the band to the aorta, and twenty-eight days after the wiring of the aneurism. In this case also the constriction of the aorta caused no symptoms which were disquieting either to the surgeons or to the patient. There was no evidence of impairment of the blood supply to the spinal cord or to the legs. The operation caused a striking decrease in the size of the aneurism and a great diminution of the pain. It is to be noted that this aneurism was very well suited for operative interference, since it was saccular and gave origin to no important vessels.

The Significance of the Waxy Casts in the Urine.—Emerson⁸ states that waxy casts "occur in any nephritis with granular casts, especially when the urine is diminished, or just before death," and that "they are probably a further modifica-

tion of the granular detritus of epithelial cells." Brugsch and Schittenhelm⁹ agree with the latter statement. Two factors would thus seem necessary for the appearance of waxy casts: an injury (toxic, mechanical) of the renal epithelium, and a scanty flow of urine. Old granular casts, moulded directly from epithelial débris, probably become changed into waxy casts when compelled to remain a long time in the urinary tubules because of a diminished secretion of urine. Now the application of a band to the aorta, so as greatly to decrease the blood supply to the kidneys, brings about the conditions just described.*

From the observations made in these two cases we may conclude that the presence of the large waxy casts in both was due to the diminished blood supply to the kidneys, brought about by the constriction of the aorta; in the second case this constriction was just above the renal arteries, but in the other, first of the thoracic aorta, and then of the abdominal aorta below the origin of the inferior mesenteric artery. The autopsy findings in Case II, in which the right renal vein was enormously distended, lend some support to this supposition. In this case the constant presence of the casts in the urine, even after the restoration of the normal blood supply to the organs below the band, is probably to be attributed to the obstruction to the vessels of the right kidney. This kidney at autopsy showed marked degenerative changes.

CONCLUSIONS.

1. The pain of an abdominal aneurism may be greatly lessened and its growth checked by the application of a partially occluding metallic band to the aorta, proximal to the aneurism. When the aneurism is saccular and gives origin to no important vessels a cure is possible by this means.

2. When the band produces an anæmia of the kidneys,

* For the effect of temporary occlusion of the renal vessels, see the article by Eisendrath and Strauss in the *Journal of the American Medical Association* for Dec. 31, 1910.

there appear for a time large numbers of waxy casts in the urine.

3. It is suggested that the sudden appearances of these casts might, in the absence of other demonstrable causes, be considered as possibly indicative of an obstruction to the circulation of one or of both kidneys.

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NEGATIVE TENSION DRAINAGE IN THE TREATMENT OF EMPYEMA.

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It is still necessary to preface one's remarks upon the treatment of thoracic empyema with an exhortation to the general practitioner to be more diligent in the pursuit of this condition. Early diagnosis secures for the patient a better prognosis as to life, and, in practically all cases, insures him against the discomfort of prolonged dressings and the exhaustion and dangers which attend chronic suppuration; not to mention the lesser evils of deformity, permanent restriction of the respiratory function, or the distress which enforced idleness frequently entails.

As the vast majority of empyemas are of the metapneumonic type, it should be the habit of the physician, as soon as a diagnosis of pneumonia is made, to have constantly before him the possibility of the development of this complication. A delayed crisis or a renewal of the temperature after crisis, the occurrence of chills and sweating, or the detection of any change in the physical signs, such as the presence of movable dulness or cardiac displacement, should immediately arouse suspicion. When such a suspicion is aroused, persistent efforts should be made to locate the pus. The one reliable method of investigation at this juncture is the use of the exploratory needle. A single negative puncture should not salve the conscience of the attending physician, as it does not relieve him of responsibility should the symptoms continue. With the aid of one of the many local anæsthetics, multiple punctures may be performed without discomfort to the patient, and there are few regions of the chest which may not be thus explored with discretion, including even the danger

zone—the costodiaphragmatic triangle below the eighth rib. Fortunately the majority of empyemas may not escape the searchings of the exploratory needle. Exceptions there are, of course, notably the mural forms of empyema, which are not infrequently secondary to marginal or peripheral lung abscess; small interlobar collections; and those cases in which the pus is located between the diaphragm and the base of the lung, which, especially in children, are frequently characterized by a train of symptoms pointing to peritoneal rather than pleural infection. In cases where an early diagnosis is established we may now with certainty prevent the occurrence of chronic empyema.

As Doctor Hill and I were able to show in our experiments upon rabbits and dogs, intrathoracic cavities, equivalent in area to the space occupied by the whole or part of one lung, are readily obliterated by compensatory changes in the remaining pulmonary tissue, deflection of the mediastinum and its contents towards the cavity, and upward retraction of the diaphragm; providing always that the tension within the cavity is less than the average intrapulmonic tension—in other words, is a negative tension. In the obliteration of an intrapleural cavity following acute empyema, the aid of the same physiological and physical agents may be invoked to secure a similar rearrangement of the anatomical structures forming the walls of such a cavity.

The indefinite persistence of an intrapleural cavity following free and dependent drainage of an empyema (other than tuberculous) is invariably due to pneumothorax. Under ordinary conditions an empyemic cavity is directly exposed to atmospheric pressure at each dressing, and this pressure persists until saturation of the dressings prevents further ingress of air, while permitting the escape of both air and pus during coughing or forced expiration. By this slender means a certain degree of negative tension is developed within the cavity during inspiration; the granulating pleuræ in the peripheral zone of the cavity are brought together and adhere; granulous retraction further coopts the separated pleuræ until the

whole cavity is, in the majority of cases, finally obliterated, not because of the inherent tendency of the lung to expand in the face of atmospheric pressure, but because of the inherent tendency of granulation tissue to contract, and because of the periodic respite from atmospheric pressure afforded by the pus soaked dressing.

Until recently surgeons have looked upon the establishment of efficient drainage as the one important consideration. Too little attention has been bestowed upon the physiological aspect of the problem. Numerous writers upon the subject of empyema have, even within the last five years, insisted upon the inherent tendency of the lung to expand in the face of atmospheric pressure. Although sporadic efforts have been made from time to time to excite the interest of the surgeon in the mechanism of the respiratory function and its important bearing upon the treatment of thoracic empyema, the spirit prior to 1909 was all in favor of compelling the chest wall to conform to the lung, rather than the lung to the chest wall; the one universal concession to the physiological being in the form of pus soaked dressings.

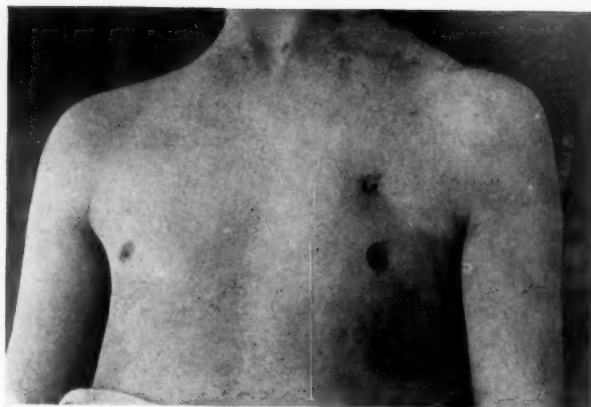
Among the early disciples with a physiological bent should be mentioned Buelau, who in 1891 reported the successful use of intercostal siphon drainage. This method undoubtedly produced a certain degree of negative tension within the empyemic cavity and, in the inventor's hands, proved efficient in preventing pneumothorax. A distinct advance upon this method, that of continuous aspiration, was first suggested by Perthes, and is still practised in European clinics. In its application Perthes performed a preliminary resection of the rib. Continuous aspiration was effected by connecting the drainage tube with a Bunsen water pump. Hutton in 1898, Baylor in 1899, and Williams in 1900—all English writers—described an air-tight dressing fitted with a valvular mechanism which permitted the escape of pus and air during forced expiration or coughing. Still later, Thiersch employed the valve principle by attaching to a catheter introduced between the ribs a section of thin rubber tubing, which collapsed during

FIG. 1.



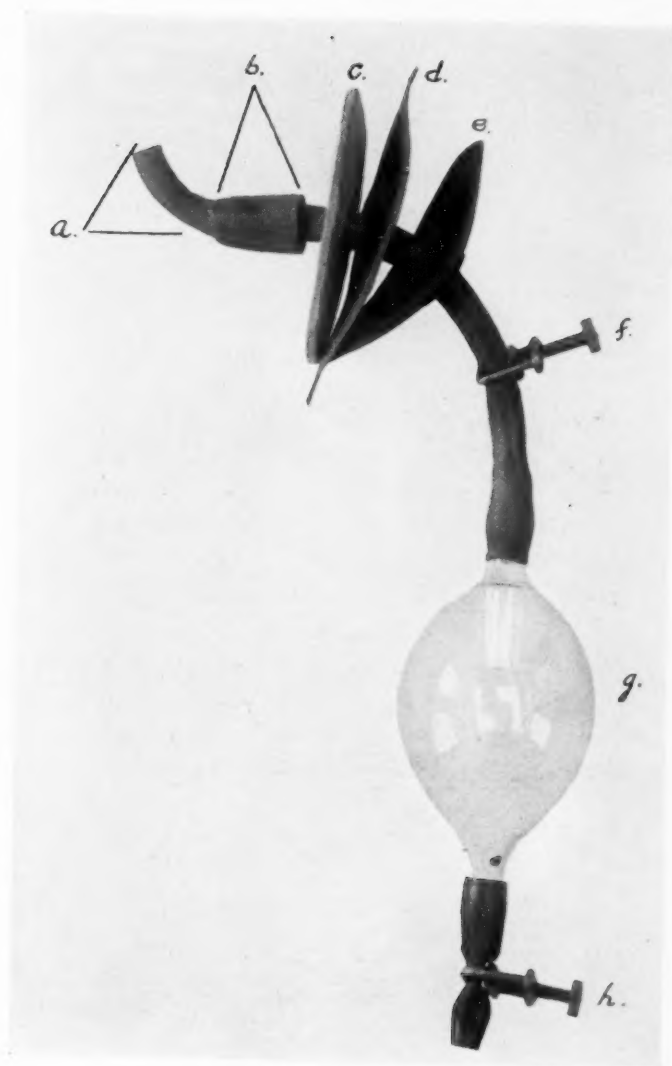
I, circular knife; II and III, periosteal elevators notched for Gigli saw.

FIG. 2.



Recent scar following circular incision.

FIG. 13.



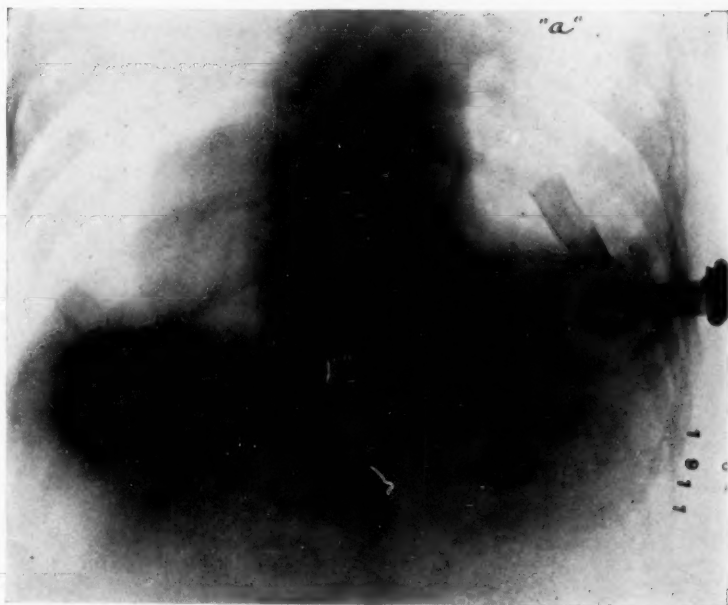
Moulded drainage tube and glass collecting bulb. *a*, drainage openings; *b*, tapered rubber cone fused with tube; *c*, oval felt pad $4\frac{1}{2} \times 8$ cm., smeared on inner surface with carbolated zinc ointment; *d*, square flange of dentist's rubber dam 8×11 cm., with small central perforation; *e*, oval re-enforced rubber shoulder $4\frac{1}{2} \times 8$ cm., with central vulcanized rubber spool to give added stability to the dressing and support to the drainage apparatus; *f*, valve for occlusion of tube while bulb is being changed; *g*, glass collecting bulb; *h*, lower valve to permit of exhaustion of cavity and bulb.

FIG. 4.



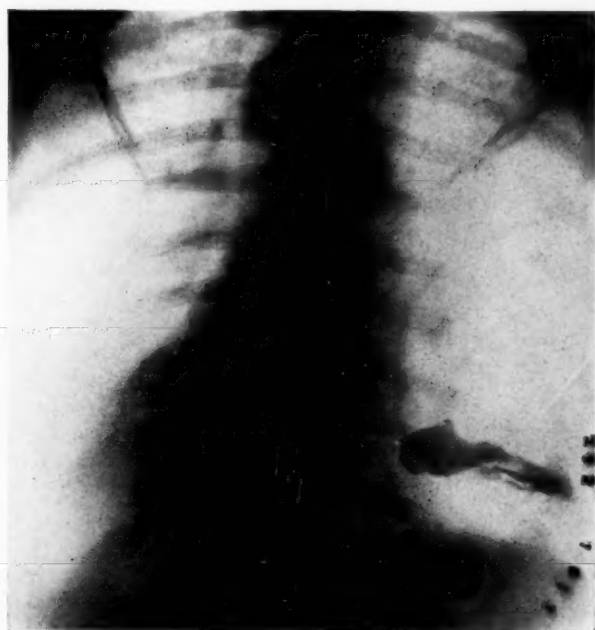
Drainage tube with parts arranged for insertion. The square rubber flange is fixed to the skin by means of four strips of zinc oxide plaster (warmed), the upper and lower strips embracing the two poles of the outer shoulder piece. A roller bandage completes the dressing. When the dressing is being changed, the skin should be smeared with zinc oxide ointment and the excess wiped off before adhesive strips are reapplied. If the discharge is profuse, capillary leakage may occur for the first two or three days, but pneumothorax is absolutely prevented. The upward turn of the inner extremity of the tube is designed to prevent painful pressure upon the diaphragm or lung. As the inner wall of the cavity approaches the chest wall, a tube with a shorter projection beyond the cone is employed. If there is no danger of pocketing, the tube may be cut off at the apex of the cone.

FIG. 5.



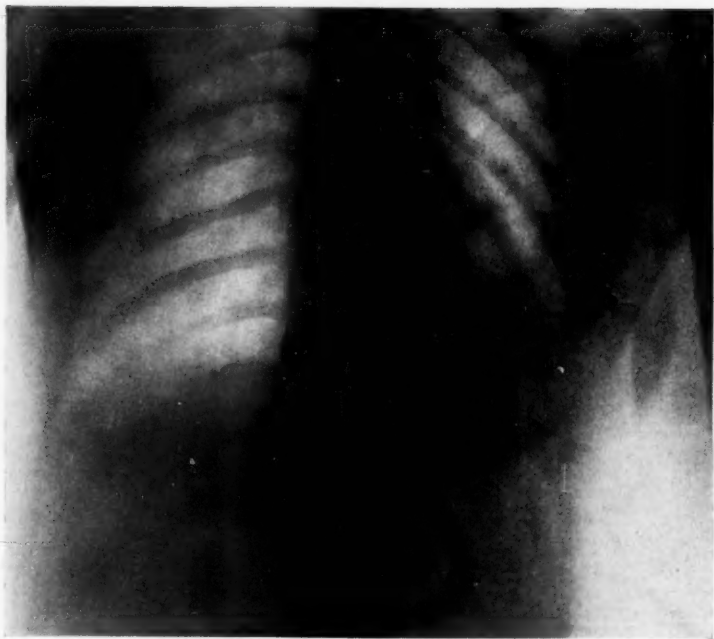
Print from skiagram of Case I (right posterior view). showing upper limit of cavity at "a"; also upward retraction of the diaphragm under negative tension.

FIG. 6.



Print from skiagram of Case I after injection of bismuth paste, showing extent of remaining sinus, and lowered position of diaphragm.

FIG. 7.



Print from skiagram of Case II (left anterior view), showing the marked deflection of the mediastinum (pericardium) to the left, the apex of the heart shadow touching the left lateral plane of the thorax.

inspiration and prevented the entrance of air into the thorax. Unfortunately all these appliances fail to maintain a partial vacuum for more than a few days; and while intermittent siphonage or aspiration is a vast improvement upon the wholly defective mechanism of the pus soaked dressing, the aim of all such appliances is to secure absolute and continuous air-tight closure.

So far as I am aware, but two methods of drainage have been described which are efficient in preventing pneumothorax, namely, that of rib trephining, described by Dr. Samuel Robinson of Boston in the October number of the *Boston Medical and Surgical Journal*, and that which I described in the *ANNALS OF SURGERY*, October, 1910.

In applying the dressing which I have devised, from two to three centimetres of the rib are resected under local anæsthesia before the pleura is opened. For this preliminary thoracotomy I have found the following method to be the most satisfactory. Instead of the usual linear incision, the skin opening is made with a circular knife (Fig. 1); the muscular layers are divided in the long axis of the rib; and flaps of periosteum are raised. The posterior reflection of the periosteum is then separated from the rib by one of the instruments shown in Fig. 1 (II and III), which are provided with a notch for threading a Gigli saw. In place of rib shears, which produce unnecessary injury to the bone, the wire saw is used to remove the desired length of rib, and the cancellous tissue of the exposed rib stumps is plugged with Horsley's wax. No skin sutures are employed. I find that by this method wound infection is less pronounced, and that granulous retraction is so rapid that a smaller tube is firmly grasped within a few days. The scar resulting from the circular incision is very much less marked than that resulting from the linear incision (Fig. 2).

The drainage tube now used is, in several minor details, an improvement upon that first devised (Figs. 3 and 4).

Before the thorax is opened, all parts of the tube should be put together with the lower valve closed, in readiness for prompt insertion. The posterior reflection of the periosteum

and the parietal pleura are then incised and the pus is allowed to escape. As soon as there is a tendency for air to enter the thorax, the wound should be plugged with the finger during inspiration. In many cases the patient can render assistance by forced expiratory movements with the glottis closed and by holding the breath in expiration at the moment the tube is inserted. After insertion, the tube is held firmly against the chest wall while the adhesive strips are adjusted and a gauze bandage is applied. The nozzle of a collapsed Politzer bag is then inserted into the tube below the lower valve, and this valve is opened. If this manœuvre is repeated, the contents of the empyemic cavity may be exhausted wholly or in part, leaving the cavity under negative tension. For the first twenty-four hours, at least, this tension should not exceed the pressure of ten millimetres of mercury. Too great a negative tension produces bleeding from the visceral pleura; or, in cases where rapid re-expansion of the lung takes place, pocketing may occur. In the early stages the Politzer bag or other means of aspiration should be applied each time the collecting bulb is changed, and later on at regular intervals. Negative tension within the cavity not only promotes outward expansion of the lung, but to an exactly equivalent degree tends to hold the dressing in apposition with the chest wall, so that drainage of the operation wound actually takes place into the empyemic cavity.

Where cyanosis is marked at the time of operation, and in cases of double empyema, the use of a positive pressure mask, such as that previously described, is indicated.

Usually within twenty-four hours after the application of this dressing the discharge changes from purulent to seropurulent, and the serous exudation thus promoted tends rapidly to eradicate the infection.

In subacute or chronic cases obliteration of the cavity is, of course, much less rapid, but so long as there is tidal air in the cavity, such a dressing should be employed. In fact the presence of tidal air is an indication that the lung is capable of further expansion. This fact is exemplified by Case I.

In cases of pyopneumothorax, the whole or part of one lobe may be completely collapsed and airless, and even hyper-pressure with the mask may be found quite ineffective in producing re-expansion. In these cases there occurs a rapid infiltration of the collapsed alveolar walls with connective-tissue cells, and where this alveolar fibrosis is advanced, the lobe or portion of the lobe may be permanently lost as a respiratory organ. That obliteration of the cavity after drainage may, however, be effected is well illustrated by Case II.

Among other advantages of this method of treatment may be mentioned the infrequency of the dressings, the absence of odor, and the fact that one is able from day to day to note the amount and character of the discharge. Patients may be allowed to go about without interrupting the process of aspiration.

When the discharge has fallen below ten cubic centimetres in twenty-four hours, the use of the tube may be discontinued, and in subacute or chronic cases where obliteration of the cavity has been comparatively slow, bismuth paste may be used with advantage.

In all cases of empyema the importance of fresh air and forced feeding should be emphasized. Even in cases where drainage is established early, and where rapid obliteration of the cavity occurs, there may be complete absence of healing for several days.

ILLUSTRATIVE CASES.

CASE I.—*Subacute empyema.* J., aged sixty-eight years, had a chill November 10, 1910, followed by symptoms of pneumonia at the right base. On the ninth day the temperature was 100° – 102.2° . On the seventeenth day it reached 103° ; on the nineteenth day, 103.2° ; and by the twenty-fifth day it had assumed a septic type, oscillating between 98.2° and 102.2° . On the thirty-first day an exploratory puncture was negative. The temperature was 98.3° – 100° . On the thirty-sixth day, December 17, a second puncture yielded pus. The patient was admitted to the hospital, and thoracotomy was performed on the same day. A large quantity of foetid pus was evacuated. Cultures showed a pure growth

of pneumococcus. From December 17 until January 4 the pus-soaked dressings were changed twice daily. On the latter date, when by the courtesy of Dr. J. Alex. Hutchison the case was transferred to my care, the discharge was still profuse, greenish yellow, and contained large clots like nummular sputum. There was no evidence of repair in the thoracotomy wound. Tidal air was demonstrated. The cavity measured 16 cm. vertically, 12 cm. transversely, and 6 cm. anteroposteriorly. January 4, a negative tension dressing was applied, and at the end of 24 hours there was a marked change in the character of the discharge. During the following 27 days there were seven dressings. For further particulars one should consult the accompanying pus chart.

EMPHYEMA (SUBACUTE).

Negative tension dressing applied January 4, 1911, 17 days after operation.

Date.	24 hours discharge c.c.	Character of discharge.	Remarks.
Jan. 5	58	Purulent	Slightly foetid.
Jan. 6	108	Sero-pur.	Continuous suction.
Jan. 7	55	Sero-pur.	Intermittent exhaust.
Jan. 8	Not est.	Intermittent exhaust; 2d dressing.
Jan. 9	36	Sero-pur.	Intermittent exhaust.
Jan. 10	34	Sero-pur.	Intermittent exhaust.
Jan. 11	36	Sero-pur.	Intermittent exhaust.
Jan. 12	Not est.	Sero-pur.	Intermittent exhaust.
Jan. 13	35	Sero-pur.	Intermittent exhaust; 3d dressing.
Jan. 14	30	Sero-pur.	Intermittent exhaust.
Jan. 15	33	Sero-pur.	Intermittent exhaust.
Jan. 16	30	Sero-pur.	Intermittent exhaust.
Jan. 17	30	Sero-pur.	Intermittent exhaust; 4th dressing.
Jan. 18	13	Sero-pur.	Intermittent exhaust.
Jan. 19	13	Sero-pur.	Intermittent exhaust.
Jan. 20	15	Sero-pur.	Intermittent exhaust; 5th dressing.
Jan. 21	15	Sero-pur.	Intermittent exhaust.
Jan. 22	14	Sero-pur.	Intermittent exhaust.
Jan. 23	14	Sero-pur.	Intermittent exhaust.
Jan. 24	10	Serous	Intermittent exhaust; 6th dressing.
Jan. 25	10	Serous	Intermittent exhaust.
Jan. 26	8	Serous	Intermittent exhaust.
Jan. 27	10	Serous	Intermittent exhaust; 7th dressing.
Jan. 28	8	Serous	Intermittent exhaust.
Jan. 29	8	Serous	Intermittent exhaust.
Jan. 30	7	Serous	Intermittent exhaust.
Jan. 31	7	Serous	Intermittent exhaust; 8th dressing.
Feb. 1	4	Serous	Intermittent exhaust.
Feb. 2	2	Serous	Bismuth paste No. I, 3 c.c.
Feb. 6	Bismuth paste No. II, 2 c.c.
			No further discharge.

CASE II.—*Pyopneumothorax (secondary to peripheral lung abscess)*. H., a girl, aged fifteen years. Illness began April 19, 1910, with a chill followed by symptoms of left-sided pneumonia. On the eighth day (April 26) the patient expectorated a large quantity of foetid pus, and the temperature fell from 102.3° to 100° . On the ninth day the highest temperature was 101° . On the tenth day, however, the temperature rose again to 103° , and subsequently the cough and dyspnoea became more urgent. When the patient was seen with Dr. Lafleur on the nineteenth day of the illness, the temperature was 103.2° , pulse 130, respirations 38. There was frequent cough with expectoration of purulent, blood-stained, foetid sputum. There was movable dulness in the axilla and left base. In the right lateral position the "coin sound" was heard in the anterior axillary line at the level of the fourth rib. The heart dulness occupied the midsternal position. Under local anaesthesia a rib resection and thoracotomy was performed at the level of the eighth rib in the midscapular line. A large quantity of thin, blood-stained, foetid pus was evacuated. The pressure mask was applied, and the deflection of the mediastinum was corrected, although there was no evidence of re-expansion in the collapsed portion of the lower lobe. Negative tension drainage was established. When the pressure mask was applied, the pulse was 140, and the patient was quite cyanosed. With the relief of pressure upon the mediastinum and healthy lung, the cyanosis promptly disappeared. At each subsequent dressing pressure was used while the tube was being changed. The large cavity resulting from the pyopneumothorax was entirely obliterated within three weeks by the compensatory expansion of the upper lobe, deflection of the mediastinum and sound lung toward the cavity, and upward retraction of the diaphragm. There was no evidence that the collapsed portion of the left lung had re-expanded.

Examination ten months after operation shows the area of cardiac dulness to extend from a line 1 cm. to the left of the left sternal border, 9 cm. towards the left axilla, with the apex beat in the sixth interspace in the anterior axillary line; that is to say, the mediastinum at this point touches the lateral plane of the body. The resonance and breath sounds are normal to the level of the fourth rib in front, in the apex of the axilla, and behind to the level of the eighth rib. In the lower axilla and

below the eighth rib behind there is dulness and complete absence of breath sounds, the costodiaphragmatic triangle having been obliterated by the upward retraction of the diaphragm. During deep inspiration there is retraction of the scar, which is evidently attached to the diaphragm. The skiagram shows the deflection of the mediastinum, as above described.

CASE III.—*Acute empyema*. T. H., a boy, aged seventeen years, developed left-sided pneumonia March 10, complicated on the fifth day by pericarditis. The temperature fell on the ninth

EMPYEMA (ACUTE).

Negative tension drainage.

Date.	24 hours discharge c.c.	Character of discharge.	Remarks.
Mch. 21	560	Purulent	
Mch. 22	Not est.	Purulent	Intermittent exhaust; 2d dressing.
Mch. 23	625	Purulent	Intermittent exhaust; 3d dressing.
Mch. 24	620	Purulent	Intermittent exhaust.
Mch. 25	640	Purulent	Intermittent exhaust; 4th dressing.
Mch. 26	360	Sero-pur.	Intermittent exhaust.
Mch. 27	250	Sero-pur.	Intermittent exhaust.
Mch. 28	230	Sero-pur.	Intermittent exhaust.
Mch. 29	478	Sero-hemor- rhagic	Continuous suction.
Mch. 30	165	Serous	Intermittent exhaust; 5th dressing.
Mch. 31	60	Serous	Intermittent exhaust.
Apr. 1	65	Serous	Intermittent exhaust.
Apr. 2	55	Serous	Intermittent exhaust; 6th dressing. (Cavity obliterated.)
Apr. 3	20	Serous	Intermittent exhaust.
Apr. 4	15	Serous	Tube removed.

day by slow crisis to 99.2°. On the eleventh day there was a slight febrile reaction, the temperature rising to 99.6°, followed by profuse sweating, subnormal temperature, and severe toxic symptoms, of which delirium was the most prominent. A friction rub had made its appearance in the lower right axilla. Aspiration of the left thorax withdrew 2400 c.c. of thin pus. On the following day, March 21, the patient was seen by me at the request of Dr. G. G. Campbell, and, under local anæsthesia, resection of a portion of the sixth rib in the left posterior axillary line was performed; 540 c.c. of pus were evacuated. The cavity extended beyond the range of digital exploration. An air-tight negative tension dressing was applied without the occurrence of pneu-

mothorax. Apart from symptoms of bronchopneumonia in the right axillary zone, the patient made an uneventful recovery. On the twelfth day after operation the cavity was found to be entirely obliterated, although negative tension was maintained for two days longer with a short tube, to insure the complete obliteration of the drainage tract.

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A STUDY OF CARCINOMA MASTITOIDES.*

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IN examining the very extensive literature of mammary carcinoma, there is occasionally noted a rare and peculiar variety of this neoplasm, designated by various authorities as "mastitis carcinosa," "inflamed cancer," "acute brawny cancer," and other terms. A close analysis of these scattered cases has shown that the tumor described is the same in all of the reports, and that the general characteristics of this growth are, that it is a very rapid, fulminating variety of breast cancer, which by setting up violent irritation, produces a round-cell infiltration closely simulating a primary mastitis. It is to this group or variety that the writer has applied the term carcinoma mastitoides.

The condition appears to have been first described by Volkmann¹ in 1875, and was styled by him mastitis carcinosa. The other later writers have in general dismissed the subject without detail, calling such tumors inflamed or acute cancer. W. R. Williams² describes a rare form of cancer, in which the whole of one or both breasts may be simultaneously involved. It arises suddenly, progresses rapidly, and is often accompanied by inflammatory phenomena. No special tumor is formed, but the whole breast becomes enlarged and hard, the skin reddened, œdematous, and adherent, and the subcutaneous veins unduly visible. The adjacent lymph-glands are usually soon invaded, and there is general dissemination of the disease, with death from acute toxæmia, its total duration seldom exceeding a few months. Most cases, but not all, arise in connection with pregnancy and lactation.

The disease usually affects women in the first half of life, and is most frequently associated with late pregnancy or lacta-

* Read before the Philadelphia Academy of Surgery, March 6, 1911.

tion. It spreads with marked rapidity, gives rise to profound toxæmia and early metastasis, death appearing in less than a year from the onset in most of the reported cases.

The growth usually manifests itself as a general, painful, and rapid enlargement of the entire breast, without the presence of any previously noted mass or area of induration. The gland becomes reddened, hot, œdematous, and may present a sense of fluctuation. Appearing, as it most frequently does, shortly after parturition, the similarity to acute mastitis is marked, and many patients have been persistently treated on this basis. The skin shortly becomes infiltrated and brawny, and small areas of necrosis may appear. The nipple may or may not be retracted, and the axillary and supraclavicular glands are early enlarged in the majority of instances. The skin of the thorax immediately surrounding the breast may become indurated and reddened; there is usually some elevation of temperature, and locally the part is hot. A point of interest is, that though small abscesses are occasionally noted, in no case did the breast tissue break down *en masse*. Cachexia is profound and metastasis rapid, death transpiring from toxæmia.

Diagnosis.—The differentiation of this form of carcinoma from an acute purulent mastitis presents the greatest difficulty, and in many cases can only be definitely determined by the microscopic examination of an excised portion of tissue. In general it may be said, that temperature is not so high in carcinoma mastitoides as in mastitis; the skin is usually more brawny and adherent to the underlying tissues, while the early enlargement of the adjacent lymph chain is of no diagnostic value as it may readily appear in both diseases.

On incising such a tumor, there will be found a fairly firm tissue, which may or may not present small abscess cavities. The substance of the growth is usually firm and fibrous, of a purplish red color, and frequently exhibits small, isolated areas of hemorrhage. There are usually scattered throughout the gland small necrotic spots, sometimes abscesses of considerable size. The contiguous skin is markedly indu-

rated and oedematous, the induration extending, in the writer's case, beyond the middle line anteriorly and to the postaxillary line posteriorly.

Prognosis.—The prognosis is uniformly bad, this being one of the most rapidly fatal of all malignant growths. Billroth³ reports a case in which death from toxæmia occurred within six weeks from the discovery of the tumors.

Treatment.—This should, of course, be radical extirpation of the breast and lymph-glands, immediately upon the diagnosis being made. In view of the relatively large number of these cases, it would seem wise to excise for microscopic examination a small portion of the breast in all doubtful cases of acute mastitis which do not yield promptly to antiphlogistic treatment. In the writer's case, the patient had been treated expectantly for three months with a diagnosis of mastitis. The case in detail was as follows:

M. L., thirty-three, married, was referred to me by Dr. R. D. Rhein, Aug. 27, 1910. The family history was irrelevant, and she had previously been a strong, healthy young woman. Five months before, she had been easily delivered of a normal, full-term child. One week after delivery she noticed a "lump" in the left breast, which was treated by the usual rubbings with oils, etc., but steadily increased in size and became hot, tender, reddened, and painful. At this time she had some fever, and the breast was incised without result. She had been seen by several physicians, all of whom confirmed the diagnosis, until she visited Dr. Rhein, who suspected some malignant change.

On examination the patient was found to be a well-nourished young woman, the mucous membranes somewhat pale, chest negative, temperature normal. The right breast was lactating, the abdomen was negative.

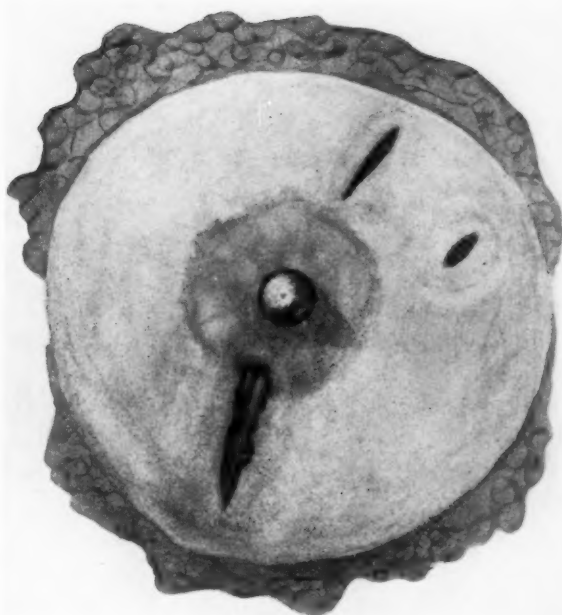
The left breast was enlarged to the size of a large grape fruit, was brawny in consistency, purplish red in color. The nipple was somewhat retracted, the skin of the "pig skin" type; the axillary glands appreciably enlarged, and the entire left side of the chest wall indurated and brawny. On palpation there was noticed considerable local heat and a distinct sense of fluctuation deep in the body of the gland. Interstitial mastitis with a deep,

small abscess was diagnosed, and under light anæsthesia deep radial incisions were made, to the pectoral muscles. The breast tissue was found to be firm and tense, of a reddish gray color, with a few scattered, localized hemorrhagic areas, and several small abscesses. After a few days, the tissue began to break down *en masse*, with a profuse discharge of thick, foul pus. At the expiration of ten days it was found that, though the degenerative process had largely ceased, the breast was, if anything, larger than before and still tense. Accordingly, radical excision was decided upon and performed at the Gynæcean Hospital in the presence of several surgeons of prominence, none of whom cared to offer a definite opinion as to the nature of the growth. The enlarged axillary glands were removed together with the breast and the pectoral muscles.

Owing to the induration of the surrounding integument, there was a marked defect in the wound which required skin grafting. The incision healed slowly, and within a week many dark brown, shot-like nodules appeared along the line of the scar. These nodules broke down into shallow ulcers, which healed and were in turn followed by more hard nodules. In November, six weeks following the operation, the patient began to complain of headache, pains in the chest, and a mass in the right breast. She lost considerable flesh, and developed the complexion and weakness of profound cachexia. December 1, the right breast was excised, the mass in its outer lower quadrant having grown to the size of an orange and being somewhat tender on palpation. This breast was unfortunately destroyed by a misunderstanding of the nurse. The wound healed at once and gave no further trouble. December 15 the woman had grown much weaker and suddenly developed very rapid breathing with a left sided pleurisy. About 500 c.c. of clear serous fluid was withdrawn from the left pleural cavity, with some relief. Within a few days she developed a basal meningitis and died in coma December 20, just eight months after the first knowledge of any disease of the breast. Autopsy was refused.

Pathological Examination.—The specimen consists of the left mammary gland. The organ is hemispherical in shape, measures 12 x 12 cm., with a maximum thickness of 6 cm., is hard and indurated, and *in situ* was seated upon a zone of indurated subcutaneous connective tissue, extending from the sternum to the midaxillary line.

FIG. 1.



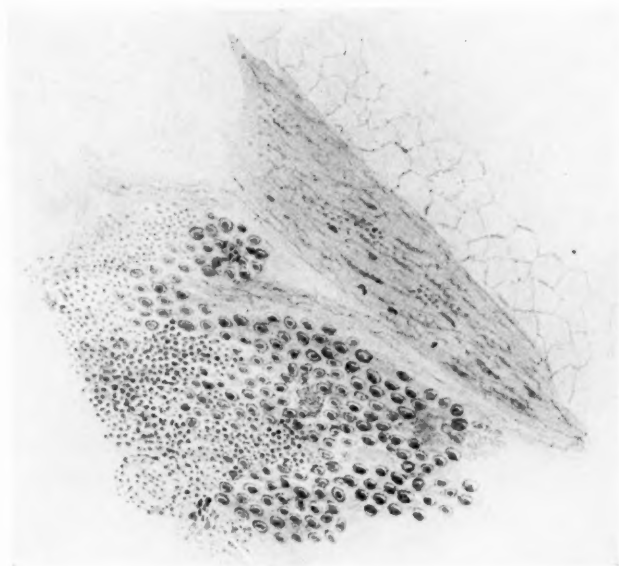
Carcinoma mastitoides, gross appearance. The diffuse nature of the tumor is shown, with the necrotic radial incisions.

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FIG. 2 B.



FIG. 2 A.



Carcinoma mastitoides. At A, is shown the poorly defined nest of cells, invaded and surrounded by a dense round-cell infiltration, with much granular debris. At B, is shown one of the papillary growths, a tubule lined with a single layer of carcinoma cells.

FIG. 3 A.

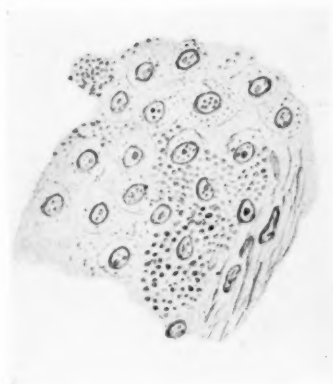
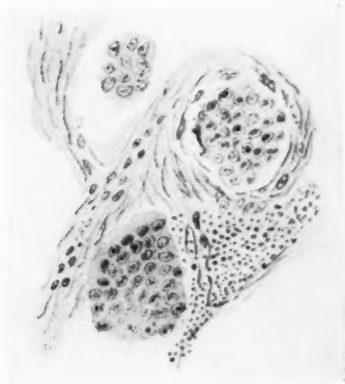


FIG. 3 B.



A, Dr. McFarland's section of Rodman's case. Notice the absence of stroma.
B, Dr. McFarland's case. The well-defined cell nests invaded by the infiltrate of leucocytes.

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The skin is of the "pig skin" variety, of a deep purplish red color, brawny, and thickened. The nipple is retracted and fixed; the areola deeply pigmented and corrugated. Three somewhat broken-down incisions extend from the nipple to the pectoral muscle.

On section, the central portion of the gland is filled with a yellowish necrotic slough. Underlying this is a dense, pink fibrous area, extending throughout the entire depth of the breast. It exudes no juice on section. Areas of fat and small abscess cavities are scattered throughout the tissue. The fascia covering the pectoralis major muscle is much thickened and indurated.

Microscopically, the growth is a somewhat complex one. It has in main the characteristics of a medullary carcinoma, growing with a small amount of connective-tissue stroma, and interspersed with groups of closely packed cell nests of the scirrhous type. In still other areas the field is typical of the carcinoma simplex. The whole picture corresponds closely with that of the latter neoplasm, as described by Rodman.⁴ The groups of cells vary greatly in their arrangement, from the dense, almost opaque nest to the long tubule or papillary outgrowth lined with the carcinomatous elements. The important feature of this tumor, however, is the secondary inflammatory reaction evidently set up by its presence. Wherever there is any considerable group of the cancer cells, it is surrounded by dense round-cell infiltration, interspersed with areas of connective-tissue hyperplasia amounting in some fields almost to fibroma. The round cells are mostly of the lymphoid type, and everywhere invade the carcinoma, surrounding isolated cells and separating the various nests from one another by dense masses of cells, granular debris, and broken-down tissue with necrosis. Many small abscesses are scattered throughout the tumor.

Fox⁵ in speaking of this specimen lays stress on the fact that the connective tissue is forming but is not at the stage where it could be classified as fibro-adenocarcinoma. He considers the round-cell infiltration secondary and invading the cancer tissue, there being well-marked cell division in the round-cell infiltrate while the cancer cells themselves show no evidence of mitosis. This point is further observed by Gross⁶ *q.v.* In a study of the reported cases, this invasion of carcinoma by a round-cell infiltrate, which from its formation appears to have been produced as a result of some action of the cancer cells, is universally noted.

Dr. Joseph McFarland⁷ has very kindly loaned the writer two specimens from his collection which are evidently of the variety in question. One of them, a student's slide from one of the German clinics, has no history attached, but the section

shows plainly a scirrhus carcinoma growing in well-defined nests, which are separated by thin connective-tissue trabeculae. Growing in and around the cells is a well-marked round-cell infiltration, which in other fields has entirely replaced the normal breast tissue. This is shown somewhat diagrammatically in Fig. 3 *B*. The second section (Fig. 3 *A*) is from Rodman's case, *q.v.* Here there is a medullary carcinoma, growing without stroma and surrounded and invaded by a dense collection of polymorphonuclear leucocytes. The carcinoma cells are crowded with leucocytes and granular debris.

In the analysis of this special variety of carcinoma, two features are of paramount interest—the pathogenesis and the diagnosis.

It has been seen that morphologically carcinoma mastitoides does not differ from certain forms of carcinoma simplex, and that the marked difference which does exist is due entirely to the interaction of the carcinoma and the profound inflammatory reaction produced by it. It follows, then, that this excessive reaction of these especial cancer cells upon the surrounding tissues—a reaction sufficiently marked to engender a general, diffuse, round-cell infiltrate and connective-tissue hyperplasia so profound as to frequently eventuate in breakdown and abscess formation—must be based either upon some peculiar toxin formed by the cells themselves, or upon a localized loss of resistance to tumor invasion, existent in the breast itself.

Inasmuch as these growths are almost always found in mamæ either in early lactation or the last weeks of pregnancy, when the glands are functionally at the height of their activity, it would seem that this condition is the determining factor. The exact process can only be conclusively described when more complete knowledge of the chemistry, notably the toxin forming power of carcinoma, is attained. It seems a logical deduction, however, that when the essential elements of the mammary gland are in full activity, fulfilling their excessive and occasional function—the secretion of milk—that they must be exceedingly vulnerable to the action of any foreign

toxin, as a result of which action the pronounced inflammatory response is a direct sequence. The diagnosis, as has been said, presents the greatest difficulty, and the only scientific procedure is to excise a small portion of tissue for microscopic examination in all cases of supposed acute mastitis that do not yield to treatment which should ordinarily effect a prompt reduction of the inflammation. The reported cases in brief are as follows:

CASE I (RODMAN⁸).—A woman of forty-five years, who noted a marked retraction of the nipple of the left breast. The entire breast then began to enlarge, the greatest enlargement being in the axillary quadrant, there being, however, no distinct tumor. The process was a diffused and not a discrete one. Three months later a diagnosis of mastitis was made by a prominent surgeon. The gland was vividly red and covered with an eczematous eruption, and, indeed, closely simulated mammary abscess. The axillary and supraclavicular glands were enlarged. The growth proved to be a medullary carcinoma with pockets of pus scattered throughout. Rodman adds in his discussion that many cases of carcinoma and sarcoma may develop in pregnant or lactating women, which, while of rapid growth, cannot be classified as acute cancer, as the inflammatory symptoms are wanting.

CASE II-III (BLOODGOOD⁹).—Two cases of medullary carcinoma, simulating mastitis, with abscess formation are reported. Both of these cases had been treated on a diagnosis of mastitis before being admitted to the clinic.

CASE IV (BILLROTH¹⁰).—A thin, pale woman aged thirty-six, the mother of seven children, was admitted to the hospital when near the full term of her eighth confinement, with both breasts larger than a child's head and firmly adherent to the overlying skin. The latter was tense, shiny, congested, and marbled by bluish veins. The breast gave no milk or colostrum; there were no obviously enlarged axillary glands. The history she gave was, that five weeks previously hardness set in at the periphery of both breasts, which rapidly spread, with increase of size. The patient died a week later, the total duration of the disease being six weeks. At necropsy, both mammary glands were found invaded by a softish, lobulated reddish growth, from which milky fluid exuded on section. Histological examination revealed epithelial cylinders and alveolar gland-like formations, such as are found in ordinary breast cancers, embedded in a fibrous stroma densely infiltrated with small round cells. Secondary nodules were disseminated in the thyroid, pericardium, etc., but not in the axillary glands.

CASE V (SHEILD¹¹).—A woman, aged fifty-two, was admitted to St. George's Hospital. Six months previously the patient struck the right breast, since which she noticed a swelling which steadily increased in size. She lately had much sharp pain and has lost flesh and strength.

The right breast was greatly enlarged, the nipple deeply retracted, and the skin marked by the old scars of numerous sinuses, for she had suffered from frequent abscess of the gland. The skin generally was of a deep congested blue color, but over the axillary part of the swelling it was red and gave the appearance of inflammation. There was considerable local heat, and the axillary glands were not enlarged. The inner part of the right breast contained a hard mass. It was quite uncertain as to whether or not fluctuation existed. Mr. Peck made an exploratory incision, which revealed undoubted cancer. This was hemorrhagic, being infiltrated with blood and breaking down superficially. The whole breast was thereupon removed.

CASE VI (SHEILD).—A healthy looking woman of fifty. The right breast was generally enlarged, skin dusky and red with increase of local heat, nipple retracted and adherent. Exploratory incision with the idea that it was an abscess revealed general carcinoma. The breast was removed, with death following some time after from recurrence.

CASE VII (MORRANT BAKER¹³).—The patient was a lady of thirty-four who had been confined four months before, and who was still nursing her infant. The right breast became large, hot, tense, elastic and painful, and the skin over it was ruddy and œdematous, as if occupied by inflammatory exudation. The surgeon believed that an abscess was forming and had the breast poulticed, and it was not until six months later that the real nature of the case was declared by the appearance of numerous cancerous nodules in the skin and the rapid enlargement of the axillary glands. The mistake here arose because all the circumstances of the case suggested the probability that the breast was the seat of an abscess, and secondly, owing to the youth of the patient and the vascularity of the breast in that patient, the malignant growth was very active and attended with great vascular disturbance, leading to redness, œdema, and heat of the skin.

CASE VIII (BRYANT¹⁴ reports three cases).

A healthy looking single woman of forty-three, with acute disease of her right breast of two months' duration. The whole gland was infiltrated and the skin over it like brawn. The nipple was depressed and lost in the surrounding elevation of the breast. The axillary and supraclavicular glands were enlarged. This patient died in less than three months.

CASE IX (BRYANT).—A married woman of fifty-three, who had borne 11 children, was seen June, 1857. She had an acute brawny infiltration of her right breast and the skin over it, with œdema of the right arm. She had been perfectly well until three months before, when she noticed a swelling in the breast, which rapidly increased and became complicated with pain down the right arm. When seen, the axillary and supraclavicular glands were much enlarged, the breast was like brawn, the skin over it œdematous, and evidently infiltrated with new elements. Death occurred in three months from toxæmia.

CASE X (BRYANT).—A woman of forty-nine who had had six children presented herself with an enormously swollen, œdematous, and

indurated left breast of eight weeks' standing. There was severe pain in the part, which was worse at night, and there was at times increase of heat in the gland. The axillary glands were not involved. The integument over the breast was œdematous and pitted on pressure. In three months the axillary glands became involved, and skin over the breast became tense, reddened, and indurated. Death occurred in nine months, with a development of a similar growth in the right breast.

CASE XI (GROSS⁶).—A sterile, married woman of thirty-nine had a tumor which had acquired the volume of an egg in less than two months and contained an abscess as large as a filbert, filled with greenish pus. The abscess formed at the expense of the infiltrated connective tissue, the epithelial cells themselves not participating in the morbid process.

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EPIGASTRIC HERNIA.*

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AN epigastric hernia is that form of ventral hernia which is situated in the anterior abdominal wall, above the umbilicus, and in or near the linea alba, linea semilunaris, or in one of the lineæ transversæ of the rectus. Such a hernia may be due to a congenital or an acquired defect in the fibrous structures of the anterior wall of the abdomen, and is generally small in size and single. Exceptionally, however, they may be multiple and of considerable size, as in the case herein reported.

These small hernias were described as long ago as 1285 by Arnould de Villeneuve, in France, and in 1743, Garangeot recognized them as a possible cause of certain obscure abdominal symptoms.

Not until the latter part of the last century, however, was much attention paid to the lesion, for not until 1880 did Lucas Champonniere do the first deliberate operation for the cure of non-strangulated inguinal hernia, and Terrier, five years later, operate first for the cure of epigastric hernia. Terrier's publication of his first operated case, and his later paper insisting upon the intimate relation between these hernias and various painful abdominal conditions, did much to call attention to the subject and place the treatment upon a rational basis.

Though epigastric hernia is relatively rare, it is by no means uncommon, and possesses a literature which is quite extensive. According to the tables of Berger, based upon

*Read at a meeting of the New York Clinical Society, January 28, 1910.

an examination of 10,000 cases of hernia found at autopsy, only 116 of these, or a little over 1 per cent., were of the epigastric variety, and of these 105 were in males. This proportion of a little more than 1 per cent. may be accepted, perhaps, as a fair estimate of the relative frequency of the lesion, though the great disproportion in favor of males is not found in other smaller series of cases. Many of the subjects of epigastric hernia seen in the hospital come from the laboring classes, and lean muscular males subject to severe muscular strain furnish a fair quota of the cases. Sometimes, however, it occurs in flabby and obese women, and in emaciated, anæmic, and debilitated persons of both sexes.

Causation.—Many theories of its production have been put forward. Witzel thinks, that given a defect in the deep fascia of the anterior abdominal wall, the subperitoneal areolar tissue may be forced through it by means of increased intra-abdominal pressure, and drag with it, later, perhaps, a portion of underlying peritoneum so as to form a hernial sac.

Roser, on the other hand, thinks that the subperitoneal fat penetrates between the meshes of the linea alba, etc., and along the course of the vessels and nerves, often without the formation of a hernial sac; or in some cases the constant dragging upon this lipoma may result in sac formation and the appearance of a true hernia.

Terrier, in similar fashion, divides these hernias into four groups: (1) lipoma, or simple fat protrusion; (2) lipoma, with a peritoneal sac; (3) true epiplocele, without lipoma; (4) hernia, with omental and intestinal contents.

Heredity and the coexistence of other hernias may be of some etiological importance, but increased intra-abdominal tension, with a diminished resistance of the fibrous orifices in the anterior abdominal wall, plays the most important rôle in their production. Thus it may occur in the laborer, subject to violent muscular strains and trauma, or it may be found in the obese, with relaxed and flabby tissues and a chronic bronchitis. Hence the opposite types in lean muscular males and in fat flabby females.

Symptoms.—These consist in the presence of a tumor in the epigastrium (which may be so small as to be overlooked by both patient and physician, and only to be discovered by a careful examination of the patient in a standing position), and certain other abdominal symptoms which vary in different cases. Thus, indigestion, colic occasionally, constipation, and vomiting are complained of. Vomiting after meals, worse when standing, and relieved by lying upon the back and by reduction of the hernia. Neurasthenia, depression, and a train of curious nervous symptoms may sometimes supervene and lead to a condition which is pitiable in the extreme and due primarily at least to a small epigastric hernia.¹ The relation of these various symptoms, gastric and nervous, to what seems such an insignificant lesion has been clearly established, and the prompt subsidence after operation is striking and convincing as to the proper line of treatment to be adopted.

Diagnosis.—In true epigastric hernia this is not usually difficult, since gastric symptoms are present in full 80 per cent. of the cases, and this alone should help to differentiate the condition from one of subperitoneal lipoma or other tumor, although it is sometimes impossible to tell before operation the true from the false hernia.

The contents of the hernial sac vary widely. In some omentum alone, free or adherent, may be present, but in the larger ones, portions of stomach or a loop of small or large intestine may be found.

Sometimes these hernias are multiple protrusions through little holes at various points in the deep abdominal fascia, and some of these protrusions are true hernias and some are merely lipomata of the subperitoneal fat. Protrusion of the omentum alone into the sac of one of the smaller hernias, however, may give rise to severe and persistent abdominal pain, and gastric disturbances may result as surely from traction on the omentum in one of these small ruptures as in the

¹ R. Lemiére: Thèse de Paris, 1905, Dyspepsie et Hernie Epigastrique.

larger ones which are much less common but much less likely to be concealed. Strangulation in epigastric hernia is exceedingly rare, and the writer has been able to find the records of but two cases; one in which the small intestine was involved and another in which a portion of the wall of the stomach was involved. Both of these are reported by Massinger, and so far I have found records of no others. The report of the following case is offered as a contribution to the study of this very rare complication in an epigastric hernia.

CASE I.—Patient, a male, aged sixty-three, was admitted to Roosevelt Hospital February 15, 1909, with the following history:

He had been ill for three days with severe abdominal pain and vomiting, and distention of the abdomen had lately developed. His bowels were reported to have responded slightly to enemata, but it could not be discovered on close questioning, that gas had ever passed since the beginning of his seizure. As he was a very alcoholic individual and had suffered before from attacks of alcoholic gastritis which resembled this one, until the distention and fecal vomiting appeared, no serious consideration of the possibility of acute intestinal obstruction was entertained by his physician. The fact that there was any connection between a rather large sized epigastric hernia and his serious condition was not at first clear, but as the symptoms became more marked, a diagnosis of intestinal obstruction was made and he was sent to the hospital for operation.

On admission, examination showed a short, stocky, rather corpulent man, very drunk, nearly pulseless, and vomiting fecal looking material frequently. He walked into his room from the carriage and did not at all appreciate his serious condition, which, however, was most evident on examination. His pulse was very small and feeble and rapid, his abdomen distended and tender, and there was a good sized epigastric hernia in the middle line extending to both sides of the same for a considerable distance. This hernia was tender, irreducible, and was recognized as strangulated, and the patient prepared for immediate operation.

The operation, which was done under ether anæsthesia, had to be rapidly performed on account of the patient's very serious

condition, and an infusion of normal saline solution was run into his veins during its performance. He left the operating table in as good condition as when brought to it, but this was very bad.

Operation.—A long median incision was made above the umbilicus immediately over the hernia, and the pathology was quickly revealed. It was seen that the hernial openings were multiple, three in number, one large and two small. The principal opening was in the middle line, and there was one small opening directly above it, and another in the left linea semilunaris. Protrusion of adherent omentum was demonstrated in all the openings, and this was returned. In the principal and largest opening, in addition to a bunch of adherent omentum, there was a loop of small gut tightly strangulated and gangrenous. Immediate resection and end-to-end anastomosis by suture was rapidly done, and the wound closed. The patient was put back to bed and rallied fairly well, regaining consciousness and complaining of pain for which a hypodermic of morphine was given. This quieted him and he had been sleeping for some time when suddenly he began to do very badly, his respiration then his pulse giving out, and he died in spite of prompt measures to save him.

In a reasonably extensive operative experience the writer has never encountered a strangulated hernia of this variety, and in fact has had only two cases of strangulated ventral hernia besides this in his whole series of cases.

It is fair to say that this patient had been seen by the writer a year before his last illness, when he presented himself at the office for advice as to a right inguinal hernia and an epigastric hernia of considerable size, which was growing larger and beginning to cause pain. This hernia, however, was easily reducible. In view of the fact that the patient was a saloon keeper, a hard drinker, and not a good surgical risk, he was referred back to his physician for a report on his urine and never appeared again until his admission to the hospital in a practically moribund condition from strangulation of the epigastric hernia. His age, history, and general condition led me to be conservative about advising operation on his first visit, but there was no other recourse than operation when he finally appeared for treatment.

THE PATHOLOGY AND SYMPTOMATOLOGY OF GALL-STONES.

BASED UPON AN EXAMINATION OF OVER 400 CASES OCCURRING AT THE
LONDON HOSPITAL.

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THIS paper is based upon a careful review of the 409 cases of gall-stones occurring at the London Hospital during the ten years 1901-1910 inclusive, so that evidence either in support of or contrary to modern views on this subject might be gained. Only those cases are included where the diagnosis was proved by operative treatment.

VARIETIES OF GALL-STONES.

Gall-stones may be of many different varieties and may be multiple or single. It is, however, almost constant to find all the stones, within the gall-bladder in any one case, of the same type, although in some cases one stone may have been displaced from the gall-bladder and then have undergone secondary changes, so that it comes to differ, in its outer layers at least, from the remaining stones. Bland Sutton¹⁰ explains this similarity of the calculi on the supposition that they are all of the same age and formed by the same factors.

Gall-stones have many times been classified according to their constituents, the best known classification being that of Naunyn,⁷⁸ who divided them into six varieties. I have carefully examined and analyzed the stones from a large number of cases, and find that most of the accepted classifications will not agree with the conditions found. The following classification is simple, and all forms of biliary calculi will be found to fit into one or other of the groups.

I. *Cholesterin Calculi.*

(a) *Pure cholesterin* (Plate I, Fig. I). These are oval or rounded in shape, light yellow in color, semitransparent, and of a wax-like consistency, so that they are readily cut or indented with the finger-nail. The cut surface is homogeneous, or may be slightly crystalline. The external surface is finely nodular, and since these calculi are always single they are not faceted. They are nearly always small, but may be as large as $1\frac{1}{2}$ inches in their long diameter. Most commonly they are found impacted in the cystic duct.

(b) *Cholesterin with Bile Pigment* (Plate I, Fig. II). These are somewhat similar to the above, but the cholesterin is mixed throughout with a certain amount of pigment, usually biliverdin, so that a waxy, pale green, semitransparent calculus results. Otherwise the characters are identical with those of the pure cholesterin variety.

(c) *Cholesterin with Bile Pigment and Calcium* (Plate I, Fig. III).—These stones, although mainly consisting of cholesterin and pigment, show chemically the presence of calcium, but it is possible that the calcium is mainly present in the form of bilirubin calcium, although some is undoubtedly in the form of calcium carbonate.

The calculi are usually about $\frac{1}{2}$ inch in diameter, roughly nodular on the surface, but may show several smoothly polished facets where they have been in contact with other calculi, this factor depending upon whether they are single or multiple. They are hard, but if the amount of cholesterin be large may be easily cut or indented. More commonly they are gritty when cut with a knife. They are dull red brown in color, owing to the presence of bilirubin calcium. The cut surface is homogeneous or may be finely crystalline.

(d) *Crystalline Cholesterin with an Outer Layer of Bilirubin Calcium* (Plate I, Fig. IV).—These are rounded or roughly cuboidal calculi, varying in size from a small pea to a cherry stone. They are usually multiple, but rarely are more than three or four present. They are dark brown in color and smooth on the surface. On section the central portion

CHOLESTERIN



I. Pure Cholesterin.



II. Cholesterin mixed with bile pigment.



III. Cholesterin with calcium carbonate and pigment.



IV. Crystalline cholesterin with outer layer of bilirubin calcium.

PIGMENT.



V. Pure biliverdin calcium.



VI. Biliverdin with outer layer of cholesterol.



VII. Pure bilirubin calcium.



VIII. Bilirubin with outer layer of cholesterol.

MIXED—Laminated.



IX. Alternate layers of bilirubin calcium and cholesterol.



X. Alternate layers of biliverdin calcium and cholesterol.



XI. Large single non-faceted laminated calculus. This had ulcerated through into the intestine and caused obstruction.

MULTIPLE FACETTED CALCULI.

PLATE I.

30

is found to be formed of radiating crystals of cholesterin covered with well-marked outer layer of bilirubin calcium. When fresh this latter material may be soft and form several layers which can easily be flaked off. When dry it becomes much firmer and more compact.

II. Pigment Calculi.

(a) *Pure Biliverdin Calcium* (Plate I, Fig. V).—These form small friable calculi of a dark green color. They are very irregular on the surface, and may show many facets with an almost metallic lustre, looking not unlike small cinders. In some cases they may be somewhat larger, up to $\frac{1}{2}$ inch in their longest diameter, and smoother on the surface. When dry they become extremely friable and tend to break up into dust-like particles.

(b) *Biliverdin Cholesterin* (Plate I, Fig. VI).—These calculi are found only in the gall-bladder. They are roughly nodular on the surface and of a yellow brown color. In their longest diameter they rarely exceed $\frac{1}{2}$ inch in length. On section the centre is found to be formed of a calculus of the preceding variety, which has become coated over with a homogeneous layer of cholesterin containing perhaps a small amount of pigment.

(c) *Pure Bilirubin Calcium* (Plate I, Fig. VII).—These calculi, which, like the pure biliverdin calcium, may be found in the hepatic ducts, are formed of a dark brown material which may appear as small particles of grit or in larger masses to form a definite calculus. When fresh they are soft and friable, forming a putty-like material; when dry they become harder and show as irregular calculi often with metallic-like particles imbedded in them.

(d) *Bilirubin Cholesterin* (Plate I, Fig. VIII).—Like the biliverdin cholesterin, these calculi are found in the gall-bladder. They are generally smooth on the surface, and may be so lightly colored as to closely resemble pearls. In other cases the cholesterin may be pigmented with bilirubin. On section a centre of bilirubin calcium is seen, surrounded by a layer of cholesterin.

III. *Mixed Calculi.*

These are usually described as common gall-stones. They are extremely variable in shape, size, and number, and may be green or yellow-brown in color, according to the variety of pigment present.

If single (Plate I, Fig. XI), they are roughly nodular or even spiculated on the surface. In many these nodules correspond to depressions on the surface of the mucous membrane of the gall-bladder, and are evidently formed by the calculus being closely gripped by the gall-bladder. When fresh the surface layers are friable and are very readily flaked off, but on drying they become much finer and more compact. They are always very light in weight, owing to the amount of cholesterin present. They are very variable in size. Small ones may be only a quarter of an inch in diameter, but they may be found two or, in exceptional cases, three or more inches in their long diameter. If single the stones are roughly oval and show no facets. Those calculi which have passed into the intestine and have caused acute intestinal obstruction are usually of this nature.

If multiple, the stones are always faceted. If only a few are present each may form a section of a cylinder, the ends being faceted to accurately articulate with the stones on either side. In some cases a whole column of calculi may thus be formed to fill an elongated gall-bladder, the individual stones in some cases being one inch or more in diameter. The surfaces not in contact are then roughly nodular as in the case of a single calculus, whilst the faceted surfaces are smooth and often beautifully polished. In other cases the calculi may be present in very large numbers, when they are correspondingly smaller and each calculus may show a large number of facets. At times a very large number, several hundreds, may be articulated together to form a mosaic work completely filling the gall-bladder. The presence of facets is of value to the surgeon in showing that more than one calculus must recently have been present.

Some of these calculi are yellow-brown (Plate I, Fig. IX),

PLATE II.



a, stone from gall-bladder. Typical laminated calculi. *b*, stone from cystic duct. On section thick outer layer of pure cholesterol, remains of laminated calculus seen in centre.

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others green on the surface (Plate I, Fig. X), according to whether bilirubin or biliverdin is the pigment present.

On section the most characteristic feature of these calculi is that they are beautifully laminated. In the centre an area of friable pigmented material is seen surrounded by a layer of crystalline cholesterin, the crystals having a radiating arrangement. Outside this is a layer of biliverdin or bilirubin calcium, often mixed with a certain proportion of calcium carbonate. These layers are repeated, the number of layers depending upon the size of the calculus. The pigment layers may be either biliverdin or bilirubin calcium, or more rarely both pigments may be present in different layers.

IV. *Calcium Carbonate.*

Many of the calculi previously described contain a certain amount of calcium carbonate. Very rarely this substance may exist practically in the pure state as a biliary calculus. Among all the cases of this series there is no note of this condition having ever been present. There are specimens in the Middlesex Hospital Museum which are figured by Bland Sutton.¹⁰

Such calculi would give a well-marked shadow in a radiograph, for it is upon the presence of calcium carbonate that a radiographic shadow, in the case of gall-stones, depends.

Pathology.

Much work experimental and otherwise has been done to throw light upon the factors entering into the causation of gall-stones. Up to the middle of the nineteenth century the views of Galen put forward in the second century were held, *i.e.*, that the gall-stones were formed by coagulation of the bile. Frerichs³² taught that in stagnating bile the bile salts underwent decomposition, the reaction of the bile became acid, and the cholesterin which was held in solution thereby became precipitated. That stagnation of the bile is a strong predisposing factor seems to be beyond doubt. As Hunter⁴⁵ says, "Stagnation of the bile is an etiological factor about which

there is no dispute." Mere stagnation is, however, insufficient to give rise to a calculus. Since cholesterin, which is the most common constituent of gall-stones, is normally present in the bile in a proportion varying from 0.045 to 1.18 per cent., it is at first sight natural to suppose that this material is simply precipitated from the bile and so gives rise to a calculus. The classical work of Naunyn⁷⁸ made clear, however, the fact that this cholesterin is not derived from the bile itself, but from the epithelium of the gall-bladder, and thus it is, as will be described later, that gall-stones formed in the hepatic ducts never contain cholesterin. He also showed clearly that the formation of calculi is dependent upon an inflammation of the gall-bladder, for under such conditions the amount of cholesterin is greatly increased, and the epithelial cells shed by the inflammatory change may act as a nucleus. The microbic origin of calculi seems to have been first suggested by Galippe,³⁵ who found bacteria in biliary calculi. He seems, however, to have laid but little stress upon the inflammatory changes caused by them in the gall-bladder, but rather to have looked upon their action as being that of forming a nucleus. The close relationship of gall-stone formation to bacillary infection was more carefully worked out by Welch,¹⁰⁸ who demonstrated the presence of *Bacillus coli* and *Staphylococcus pyogenes* in the stones and in the gall-bladder. Hanot and Létienne⁴¹ found that in similar circumstances typhoid bacilli might be present, whilst Dominici³⁷ and Gilbert and Fournier³⁸ found the *Bacillus coli* present in 23 out of 70 cases examined. The latter also showed by experimental work upon animals that both the *Bacillus coli* and *Bacillus typhosus* were able to set up a cholecystitis which was followed by the formation of stones. Mignot⁷⁰ showed that gall-stones were only formed if the infection was chronic and attenuated. If the organisms were virulent an acute cholecystitis was set up but no gall-stones were formed. The nature of the organisms did not seem to be of great importance provided they were attenuated, for he showed that *Bacillus coli*, *B. typhosus*, *Staphylococci*, *Strep-*

tococci, and even *B. subtilis* were capable of giving rise to calculi. In acute infections the mucosa instead of being stimulated to excessive formation of cholesterin is probably destroyed outright.

The close relationship between microbic infection and the formation of gall-stones has been strongly supported by more recent investigators. Thus Deaver²³ found that of 94 cases in which cultures were taken *B. coli* was present in 25, *B. typhosus* in 13, *Staphylococci* in 5, *B. coli* and *staphylococcus* in 2, and unidentified organisms in 3. Funke,³³ however, examined 102 calculi and found that only 31 gave rise to a growth in bouillon. He believes from this fact that the first essential to the growth of calculi is impediment to the flow of bile, and that when this becomes stagnant infection usually follows. Although there is no doubt that stagnation will aid infection, and in this way probably acts as the predisposing factor, yet as Miyaki⁷¹ has shown by experimental work, the most common sequence of events was firstly an infection, followed by catarrhal and desquamative inflammation, then the formation of a calculus, the presence of which led to a persistent chronic cholecystitis. In this present series of cases, 48 were bacteriologically examined; 10 were sterile. Of the others *B. coli* was present in 22, *Staphylococci* in 5, *typhoid* in 2, *B. coli* and *Streptococci* in 4, *Pneumococci* in 3, and *Streptococci* and *B. pyocyaneus* in 1 case each,—figures which are in close agreement with those of Hartmann,⁴² who in 46 cases found 10 sterile, *B. coli* in 23, *Staphylococci* in 4, *Streptococci* in 2, *B. coli* and *Staphylococci* in 2, and *Streptococci* and other organisms in 3 cases.

The relationship between typhoid fever and gall-stones has been even more clearly shown. Bernheim⁹ first laid stress upon this, whilst Chiari¹⁹ demonstrated the *B. typhosus* in the gall-bladder in 19 out of 22 cases of typhoid fever. Richardson⁸⁹ has also shown the very close relationship existing between typhoid fever, cholecystitis, and cholelithiasis, while Cushing²¹ found that of his series of cases operated on for gall-stones 30 per cent. had previously suffered with

typhoid. In this series of cases the connection was not nearly so marked. Thus of the 48 cases examined, only 2 showed the presence of typhoid bacilli, while only 20 patients had a definite history of previous typhoid fever, although in hospital patients such previous history is notably unreliable. It is of interest from this point of view that both the cases in whom typhoid bacilli were found did not give a history of previous typhoid and thus it is possible that many cases, although never showing symptoms of typhoid fever, are in reality infected and act as typhoid carriers, as described by Ledingham,⁵³ although Dudgeon,²⁵ in agreement with the above figures, was only able to isolate the *Bacillus typhosus* from the bile once in 20 cases. That the typhoid bacillus has a distinct tendency to attack the gall-bladder is beyond doubt, and many cases have been recorded of acute cholecystitis occurring during the course of, or shortly after, an attack of typhoid fever, although they are relatively rare. Thus Thomas¹⁰² reported 4 cases of post-typhoid cholecystitis, in 2 of which the *B. typhosus* was isolated, but in 895 cases of typhoid there were only 12 in which cholecystitis was noted (1.3 per cent.). But from the literature he collected 154 cases of typhoidal cholecystitis, gall-stones being present in 31. The *B. typhosus* was present in the gall-bladder in 50 per cent. of all the cases, or perhaps in 95 per cent. of these occurring during the course of typhoid fever. Ashurst⁴ found only 18 cases of cholecystitis in 2864 cases of typhoid, but Quénu⁸⁸ was able to collect as many as 45 cases, from the literature, which had been operated upon. Although the above cases are chiefly those in which the gall-bladder lesion has occurred during or soon after the typhoid infection, it must be remembered that in the majority of cases the patient may not seek treatment for the gall-stones until many years afterwards. Thus in the 20 cases in this series, although in one gall-stones were discovered 4 months after the typhoid fever, the average time that had elapsed was 20 years, and in one case it was as long as 56 years, although here there was no note of any bacteriological examination of the bile. In a case recorded by

Dean²² typhoid bacilli had remained and were found in a typhoid carrier 29 years after the original infection. When dependent in this way upon typhoid fever, cholecystitis may occur in young children. Thus Armstrong² records a case of perforation of the gall-bladder from such a cause in a child of 10 years of age, and Moynihan⁷⁴ states that he has operated upon seven patients under the age of 21 for gall-stones, in all of whom there was a history of typhoid fever, and in two of them the *B. typhosus* was discovered in the bile.

Most observers therefore are in agreement that the evidence of an inflammatory factor is very strong. Aschoff and Bacmeister³ on the other hand claim that pure cholesterol calculi may be formed by stasis alone without infection or inflammation of the gall-bladder. Bacmeister⁵ states that the deposition of cholesterol is favored by the gall-bladder epithelium, but sterile bile *in vitro* at body temperature can precipitate cholesterol without noteworthy admixture of calcium. They state that they have found pure cholesterol calculi only in gall-bladders free from inflammation, and believe that cholesterol comes only from bile and not from the epithelium of the gall-bladder. Should there be inflammation, it is secondary to the calculus and due to the irritation of it. If this be so, one would expect to find pure cholesterol calculi in the common duct, but in this series I have not found this to be the case; pure cholesterol calculi have nearly always been those impacted in the cystic duct, and if one of many in the gall-bladder become so impacted, it becomes covered with a layer of pure cholesterol as will later be described. It seems, therefore, much more probable that such stones are formed, not because there is an absence of any inflammatory change, but because the pigment is shut off by the impacted calculus. They admit that calculi may be produced by inflammation, but state that such calculi are always rich in calcium either as the carbonate or combined with pigment. In this series of cases 10 were noted as having pure cholesterol calculi, all single. In 5 of these a bacteriological examination of the fluid was made. Three contained *B. coli*, 1 *Staphylococci* and 1 was

sterile. There were also 11 cases in which one of many calculi in the gall-bladder had become impacted in the cystic duct, this calculus having then become coated with a layer of pure cholesterin. Four of these had been examined bacteriologically; 1 was sterile, 1 contained *B. coli*, 1 *B. typhosus*, and 1 a *Staphylococcus*, thus pointing to the fact that even with pure cholesterin calculi there is a chronic infection of the gall-bladder.

Methods of Infection.

The organisms which give rise to infection in the gall-bladder might reach their destination by the following routes: (1) from the intestine, passing up along the cystic and common ducts; (2) along the portal vein; (3) by means of the systemic circulation.

The nature of the organisms present in such cases might throw light upon the source of infection. As pointed out, all observers are agreed that organisms of the coli group are those most frequently found, and this would at first sight strongly point to the infection having taken place either along the common duct or up the portal vein. Certain indirect evidence has also been brought forward in favor of the infection passing along the common duct. Thus MacCarty⁵⁹ records two cases where duodenal ulcers blocking the papilla of Vater were associated with gall-stones and cholecystitis, which he suggests points to an ascending infection. It is, however, equally open to suggestion here that the duodenal ulcers were due to an infection passing down to them from the gall-bladder. Lippmann⁵⁶ has isolated organisms from the common duct in numbers decreasing upwards, and Kelly⁴⁹ states that with gall-stones the bacteria are not infrequently more numerous in the lower end of the common duct than elsewhere in the biliary tract, the motile being more common than the non-motile organisms.

As Stanmore Bishop¹⁰⁰ has pointed out, however, the method of ascending infection is unlikely, for the duodenum is singularly free from micro-organisms, and even if present such organisms as are found in the intestine are of a virulence

more likely to cause an acute cholecystitis than to lead to the formation of gall-stones; moreover, the organisms are not likely to ascend against the bile stream.

There is considerably more evidence that the infection takes place through the blood stream. Thus Doerr²⁴ injected organisms into the veins of rabbits and recovered them from the gall-bladder within a few hours, catarrhal changes of this viscus being also present. Lemierre and Abrami⁵⁴ confirmed this. They injected *B. typhosus* into the vessels of a rabbit's ear and found the organisms constantly eliminated by the liver, so that they passed into the bile-ducts and caused a transient cholecystitis. They were, however, unable to isolate the organisms from the bile after inoculating the stomach with cultures through a tube. Lartigan⁵¹ showed also by experiment that if animals were fed on *B. pyocyaneus*, after ligature of the common duct, over one-half of them contained this organism in the gall-bladder.

As to whether the portal or the systemic circulation is the chief path of infection is somewhat doubtful. Owing to the work chiefly of the Italian physiologists, much stress has been laid upon the fact that one of the functions of the liver is a protective one, and that it excretes toxins and organisms absorbed by the portal system and hence a cholecystitis might be set up which would probably be chronic in nature, owing to the virulence of the organisms having been decreased by the action of the liver. Adami¹ has also emphasized the importance of the portal system as a means whereby infection is carried to the gall-bladder. Ochsner⁷⁹ has even gone so far as to suggest that in all cases the portal of entry for the organisms was a diseased appendix, but as MacCarty⁵⁹ points out, it is strange that gall-stones are so rare in young children, if such be true, whilst appendicitis is so common. He found that in 59 cases of gall-stones, 67 per cent. presented definite gross and macroscopical changes in the appendix, but he states that chronic changes in the appendix are so often found post mortem in apparently normal people that he doubts the value of these figures. In a later communication, however,

he and McGrath⁶⁰ find that, whereas in general postmortems only 17 per cent. show obliteration of the appendix lumen, in cases of cholecystitis and cholelithiasis, 44.8 per cent. show this obliteration, which obliteration they accept as evidence of a previous appendicitis.

Carmichael¹⁷ was unable to find any infection of the gall-bladder after he had injected the portal system of rabbits with *B. typhosus*, *B. coli*, and *Streptococci*. This, combined with the work of Doerr²⁴ and Lemierre and Abrami⁵⁴ mentioned above, is much in favor of the infection passing along the systemic circulation, as are also the cases reported by Bryan and Kayser.¹⁴ These authors found the specific organisms in the gall-bladder in cases of influenza and pneumonia, where presumably infection could not have taken place through the portal system. It will have been noticed that in this series of cases also there were three cases in which pure cultures of pneumococci were alone obtained from the gall-bladder.

The combination of facts that gall-stones are so much more common in women, that the *B. coli* is so much more frequently the organism present, and the fact that *B. coli* infections of other organs, especially the urinary tract, are very common in women and relatively rare in men, is suggestive that this organism is carried to the gall-bladder by means of the systemic circulation, and one is led to infer that the presence of gall-stones is often only a manifestation of a chronic septicæmia, and in this way is probably closely connected with the formation of urinary calculi.

Methods of Formation.

Having seen that calculi are dependent upon inflammatory changes in the gall-bladder, and that cholesterol is thereby formed in excess, it remains to be shown how this cholesterol is deposited from solution in the bile and how the different varieties of stone arise.

In the case of the pigment calculi, Hunter⁴⁵ states that bilirubin itself is never precipitated, but under certain circumstances it combines with calcium, this compound then being precipitated. Under ordinary circumstances bilirubin and

calcium cannot be made to combine. The addition of lime water leads eventually to a precipitation of bilirubin calcium, but this precipitation is hindered by the presence of bile salts, and only takes place with excess of lime water. He points out that, although it has been suggested that precipitation is brought about by excess of lime in the drinking water, there is no evidence that the drinking of such water increases the amount of calcium in the bile.

Naunyn⁷⁸ first showed that the presence or absence of albumin had a very important bearing, and that if egg albumin be added to bile it brings about a precipitation of bilirubin calcium. Doerr²⁴ has definitely confirmed this by experiment, and Hunter⁴⁶ states his belief that the precipitation is caused by an increased viscosity of the bile, in its turn caused by an inflammatory catarrh of the ducts. The albuminous fluid would be formed during any chronic infection, and thus further evidence is provided of the dependence of this condition upon some inflammatory change. The effect of stagnation of the bile in aiding this infection has already been described. When combination of the pigment and calcium has taken place, the insoluble material will be precipitated, usually in the form of gritty particles. At times these will combine to form a soft, friable calculus, and since, as has been shown, cholesterin is only formed from the gall-bladder mucosa, therefore all calculi formed within the intrahepatic or hepatic ducts will be formed of pure biliverdin or bilirubin calcium. In four cases only of this series was there any note as to the presence of stones in the hepatic ducts; in three of these the calculi were soft, friable masses of pigment calcium, whilst in the remaining case, where the calculi were apparently of the common mixed variety, a large number of calculi were also present in the gall-bladder and common duct, and thus it is probable that they had not been formed *in situ* but had passed upwards from the common duct. When small, however, these pure pigment calcium calculi may pass into the gall-bladder, and acting there as foreign bodies, may become coated with cholesterin and form the nucleus of a calculus. A very large number of the more common varieties of calculi

contain pure pigment calcium in the centre or the pigment may have a simple layer of cholesterin deposited upon it as in Plate I, Figs. VI and VIII.

In the case of the gall-bladder also, the question is much less simple than would at first sight appear. Naunyn⁷⁸ believed that, owing to the inflammatory condition of the epithelium, the cholesterin was simply formed in excess and was then deposited in a crystalline form on the surface of the calculus, or in the earlier stages simply upon the surface of flakes of shed epithelium, but that such is not the case is clearly shown by the fact that the fresh layers are at first amorphous but may later become crystalline. Mayo Robson⁶² brings forward evidence to show that gall-stones are more common in those who limit their nitrogenous diet, and that although according to Thudicum,¹⁰³ they are unknown in wild animals, they may occur in domesticated ones. He believes that thereby the bile salts are diminished and the cholesterin thus thrown out of solution. This fact, however, might be explained by the greater liability of domesticated animals to chronic infections.

Of late much work has been done upon the method of formation of urinary calculi, and it is probable that the facts discovered in reference to them, are true, in part, at least, in the case of gall-stones. Ord⁸³ first showed that the presence of colloids was a very important factor in the formation of such calculi, and Schede,⁹⁷ working upon the same lines, points out that in addition to the salts, colloidal substances are present especially in pathological urines. He refers to the work of Ebstein showing that an urinary calculus is not a simple aggregation of crystals but possesses a characteristic organic frame-work in which are embedded crystalline salts. The colloids occur in the form of numerous small particles or droplets, and thus the suspended colloid presents an enormous total surface area. This surface will attract and absorb a certain amount of the crystalloid in solution, which is held there more highly concentrated than elsewhere. Hence the effect of a colloid is to greatly increase the amount of crystal-

loid which can go into solution. If, now, the concentration is steadily increased, precipitation will first occur in the most concentrated parts, *i.e.*, on the surface of the colloidal particles, and thus when sedimentation occurs they will separate out together as amorphous particles. If the colloid be reversible, *i.e.*, capable of going into solution again, such as mucin for instance, the precipitate will be redissolved when the solution becomes weaker in crystalloid. If, however, it be irreversible, and the best example of such a colloid is albumin, then the precipitate will not be redissolved, but as Schede⁹⁷ has shown, it will contract and form a firm calculus. If precipitation occurs intermittently, a concentrically laminated calculus will result.

In favor of these factors applying also to gall-stones, we have the fact that the newly deposited material is always amorphous, that later it may contract and form a firm calculus or even undergo crystallization, that an albuminous framework usually described as a cement is always present, and that the calculi are not capable of being redissolved.

Therefore there is evidence that the presence of albumin or some other colloid is probably essential for the formation of calculi both in the ducts and in the gall-bladder. This albumin is provided by the inflammatory change which has already been shown to be so constant a factor, and which in the case of the gall-bladder also leads to the excessive formation of cholesterin.

The calcium may be simply derived from the calcium salts present in the bile, which under the influence of the albumin are capable of combining with the pigment, or, as Upcott¹⁰⁵ states, it may be mainly derived from mucous glands, which although present in very few numbers in health, are found in large numbers in the inflamed fundus.

Another factor upon which much stress has been laid is the presence of foreign bodies around which the material is deposited. Gérard³⁶ showed that a solution of bile salts saturated with cholesterin deposited the latter when inoculated with *B. coli*. Mignot⁷⁰ experimentally produced calculi in a

dog. The gall-bladder was artificially infected with an attenuated culture of *B. coli*. Six weeks later a thread was introduced into the gall-bladder, one end being attached to the wall. Five months later the gall-bladder was opened and two cholesterin calculi were found on the thread. Homans⁴⁴ has brought forward somewhat similar evidence from the human subject. In his case a suture was accidentally left projecting into the gall-bladder after an operation for calculi. Twenty months later a second operation was required for recurrence of symptoms. Calculi were found surrounding the previous suture and were removed.

In other cases portions of epithelium or even bacteria themselves may act as a central nucleus upon which the calculus is gradually deposited.

The mechanism of the formation of the calculi may therefore be summed up as follows: *B. coli* or other organisms are absorbed into the blood stream probably from the intestine. These organisms are carried to the gall-bladder and ducts by the blood stream, a chronic cholecystitis being thereby set up. Cholesterin is formed in excess, and a colloid material is at the same time set free in the bile. The cholesterin and pigment calcium are deposited from this in an amorphous state to form the starting point of a calculus. The deposit often occurs around some small solid particle as a nucleus. The nucleus may be single, or a large number may be present, and thus a single or multiple gall-stones may arise.

The material acting as a nucleus is usually free within the bile, but apparently in some cases the cholesterin as it is formed may remain adherent to the epithelium, so that multiple small calculi appear embedded in the mucosa. Moynihan⁷⁸ has recorded three such cases in which he found multiple small cholesterin calculi firmly adherent to the mucosa, the condition being sharply terminated at the commencement of the cystic duct. Bland Sutton¹⁰ figures a case where the mucosa had completely sloughed owing to an acute infection; it was dotted all over with small calculi.

In the case of the common variety of calculus new material

is added around the nucleus, and one of the most characteristic facts is that this material is laminated. The reason for this is difficult to see. As already stated, Schede⁹⁷ has shown that artificially formed urinary calculi may be laminated, and the explanation may therefore in this case also be that precipitation occurs irregularly, but here the laminæ have different structures, usually alternating layers of cholesterin and pigment calcium. In some cases the layers of pigment calcium may vary both in thickness and nature, so that some of the layers are formed of biliverdin and others of bilirubin calcium. In the majority of cases, however, the laminæ are the same throughout. It is possible that the lamination is due to the presence of bile within the gall-bladder being spasmodic, either from intermittent obstruction of the cystic duct from the gall-stones or from catarrh of the cystic duct acting in the same way. In any case the calculi in the gall-bladder are always of the same structure—if one is of the common laminated variety they are all of this variety.

When first formed these calculi are quite soft, and in all cases the outer layers are noticed to be so when the stone is removed. Later the material becomes much firmer, and the cholesterin, as Naunyn⁷⁸ first pointed out, becomes crystalline, hence in the larger calculi, the inner layers of cholesterin are generally crystalline.

Partly owing to the softness of the newly deposited material, but more especially to the fact that as they enlarge they must fit into one another, these calculi always show facets, and if a large number be present they form a most perfectly fitting mosaic, the faceted surfaces accurately articulating with one another and being perfectly smooth and polished.

In many cases three or four stones may form a column within the gall-bladder, reaching from the fundus to the cystic duct, and so accurately do the opposed surfaces articulate with one another that it has often been suggested that they have arisen from the fracture of a single calculus. That such is not the case is readily shown by the fact that on section these calculi will always be found to be laminated around their own

and not around a common centre. The same is true at least for the inner portions in those cases which Bland Sutton¹⁰ has drawn attention to and has figured, in which three calculi form a barrel-like mass partly filling the cystic duct and neck of the gall-bladder.

If the stone be single, it will steadily grow in size, the gall-bladder generally closely embracing it so that it is roughly oval in shape, has no facets, but often shows a roughened surface, the irregularities of which may closely fit the depressions of the mucosa of the gall-bladder. In other cases single stones may be more irregular in shape owing to the inflammatory condition having led to distortion in the shape of the gall-bladder. Thus this viscus may be partly constricted in the centre, leading to the formation of a dumb-bell calculus. In the same way calculi may be formed in pouches or diverticula of the gall-bladder, and especially in Hartmann's pouch at the commencement of the cystic duct. If one of these large single calculi be divided, well-marked laminae are seen. These are always best marked near the periphery. In the centre an irregular homogeneous mass is often seen. This may be due to secondary changes in the central material or is more probably due to the fact that the nucleus was formed of pigment calcium, which had passed down from the hepatic ducts. In some cases the centre is seen to be formed of an irregular mass of almost pure cholesterin, and it is then almost certain that the secondary changes which Naunyn⁷⁸ described have taken place. He stated that in the course of time bilirubin calcium could be dissolved out from the centre of a calculus and be replaced by cholesterin. He said that this condition might go so far as to lead to a complete metamorphosis of the calculus, a laminated calculus being ultimately replaced by one of pure cholesterin. It is almost certain, however, that this does not progress so far, cholesterin stones arising, as will be described, in a different manner.

The structure of the mixed but non-laminated calculi (Plate I, Fig. III) is probably explained by the fact that the deposition is not intermittent but regular, and hence the calculus will have the same structure throughout.

It is difficult to determine how long a time is required for the formation of definite calculi within the gall-bladder. Probably in most cases it is a matter of years. Mignot⁷⁰ states that it requires 6 months to form a well-stratified biliary calculus. Herz⁴³ records an interesting case of gall-stones with *B. typhosus* in the gall-bladder and centres of the calculi. The calculi were removed 69 days after the onset of the first attack of typhoid fever. They varied from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter. In one case in this series the first attack of typhoid had occurred 4 months before; at operation 20 calculi, the largest being $\frac{3}{4}$ inch in diameter, were removed.

Stones thus formed in the gall-bladder may pass into the cystic duct and their onward process be then stopped. Further changes in the calculus will then depend upon whether the duct is completely occluded or not. If not, the stone or stones will grow *in situ* and since all the materials which are present in the gall-bladder will still be present in the fluid around them, the newly formed material will have the same composition as the original calculus. In this way stones perhaps in a series of two or three, closely articulating together, will form a barrel-shaped mass as described by Sutton,¹⁰ which is much too large to have reached this situation by mere passage down the ducts. Such stones will in the majority of cases be found to have lost the typical laminated appearance in their outer layers, which is probably explained by the fact that in this position there is more or less constant flow of fluid around them, and hence deposition on their outer surfaces is less intermittent.

If the obliteration be complete, the course is somewhat different. In this case the bile pigment coming from the liver is unable to pass back to the gall-bladder. This latter structure, however, owing to its inflammatory state, continues to secrete mucus and cholesterin. Hence the newly deposited material will consist of practically pure cholesterin, and if the obliteration has taken place when the calculus was small, this latter will be found almost wholly formed of pure cholesterin. So constant is this that if there be only one stone

which is completely obliterating the cystic duct or neck of the gall-bladder, this stone will generally be of pure cholesterin. The converse of this is even more constant, *i.e.*, that a pure cholesterin stone will be found to be the only stone and will be obliterating the cystic duct or neck of the gall-bladder, for in the former case the calculus may have been formed in the gall-bladder, and although it has passed down to the cystic duct, may not yet have become coated with cholesterin.

If at the time of obliteration there be a considerable amount of bile in the gall-bladder, the calculus may be evenly pigmented throughout, although formed of cholesterin as in Plate I, Fig. II.

That such is the method of formation of these calculi is shown by the case in Plate II. Here the gall-bladder contained a large number, several hundreds, of common facettted calculi. The cystic duct, however, was obstructed by a larger and more irregular calculus. At first sight this appeared to be of pure cholesterin, but on cutting it open the centre was seen to be formed of a calculus similar to those in the gall-bladder, around which the cholesterin was deposited. The truth of Naunyn's contention, that secondary changes can take place in a calculus, is also well shown, for the outer laminæ of the original calculus are very irregular and are evidently in the process of being absorbed and replaced by pure cholesterin.

ETIOLOGY.

The true frequency of gall-stones is of course difficult to estimate. In post-mortem subjects only, Brockbank¹³ finds that in Manchester they form 4.4 per cent., whilst Mayo Robson⁶² for Europeans of all ages and sexes places it at 5.12 per cent. In the three years, 1908 to 1910 inclusive, 3755 post-mortem examinations were performed at the London Hospital. Among these there were 131 cases of gall-stones giving only 3.48 per cent. Among the total population the frequency is much less, but cannot be estimated with any accuracy. The 409 cases of this series, which were confirmed

by operation, occurred among a total of 76,410 cases of surgical in-patients, in the ten years, this giving 0.53 per cent.

Age.—Gall-stones are extremely rare to young children, most cases being found between the ages of 30–60. Thus in this series of 409 cases, the numbers occurring at different ages were as follows:

Age.	Number.	Age.	Number.
1–10	0	51–60	123
11–20	0	61–70	63
21–30	26	71–80	11
31–40	68	81–90	1
41–50	117		

As Moynihan⁷⁴ points out, however, in a large number of cases symptoms have been existing for many years, and thus the age frequency will to a large degree depend upon skill in diagnosis, and in older series where a definite diagnosis was not made until colic and jaundice were present, the age would be considerably higher. The following table gives the age frequencies in this series when symptoms first appeared.

Age.	Number.	Age.	Number.
1–10	3	51–60	67
11–20	27	61–70	27
21–30	57	71–80	5
31–40	122	81–90	0
41–50	101		

According to this latter table the age of onset is most commonly found between 31–40, which is in agreement with the figures of Moynihan,⁷⁴ who gives it at 40, and of Hartmann,⁴² who states that they most commonly commence before the age of 35.

It will be seen from the above tables that not a single case occurred in a patient below the age of 20, although in 30 cases there was a history of symptoms having commenced before that age. Occasionally gall-stones may be found in quite young children or even in infants. Thus Still¹⁰¹ was able to collect records of 23 cases, including 3 of his own. Ten of

them were in still-born children or in young infants. Portal and Lieutard⁸⁶ also described them as being present in the newly born.

The nature of such calculi is difficult to see, as in patients of such an age inflammatory changes in the gall-bladder would be very unlikely. It is interesting to note that in two of Still's cases the calculi were pure bilirubin calcium.

Sex.—The condition is much more common in women than in men. In this series of cases there were 347 women or 87.3 per cent., and 62 or 12.7 per cent. men. In Brockbank's¹³ post-mortem series gall-stone cases formed 7.9 per cent. of female and 2.9 per cent. of male autopsies, whilst Schroeder⁹⁸ found in Strasburg 20 per cent. in female and 4.4 per cent. in male autopsies, which would point to gall-stones being more common there than in England.

Many explanations have been given of this greater frequency in women, most of which explanations aim at finding some mechanical cause of obstruction with consequent stagnation of the bile. Thus it is often stated that it is due to the fact that women wear corsets. By their use the antero-posterior diameter of the lower thorax and upper abdomen is decreased, and hence the gall-bladder is pressed backwards, the angle which its neck makes with the cystic duct being thereby decreased and the flow of bile hindered.

It is again stated that women take much less exercise than men. The voluntary abdominal muscles are thus weaker, and their action in emptying the gall-bladder is decreased. This factor is, however, probably of but slight importance, for in this series the difference between the two sexes is very marked, and yet these women, drawn as they are from the poorer classes of the community, generally have to do extremely hard manual work and often show a muscular development relatively equal to that of the males. Since, however, enteroptosis is often associated with gall-stones, and this condition, as Keith⁴⁸ has shown, is mainly dependent upon loss of power of the abdominal muscles, loss of muscular development may indirectly act as a causative factor.

Although the above factors may be predisposing causes, it is probable that the tendency of women to become infected with the *Bacillus coli* is of much greater importance in determining the presence of gall-stones. As already shown, this organism is the one most commonly found in cases of gall-stones, rather less than 50 per cent. of the cases being apparently dependent upon it. All writers are agreed that urinary conditions due to the *Bacillus coli* are also much more frequent in women than in men. Thus Brewer¹² found that 84.6 of his cases were females, figures which correspond very closely with those for gall-stones. That there is a very close connection between gall-stones and urinary disease is shown by the fact that of the 347 female cases in this series there were 73 or 21 per cent. showing well-marked urinary symptoms, such as pain, frequency, and albuminuria, and when it is remembered that in a large number of cases bacilluria with *B. coli* may exist with no symptoms, it is probable that the percentage was much higher than this. In pursuit of this question, I have had bacteriological examinations made of the urine in ten cases of gall-stones showing no urinary symptoms. In 7 of these the *B. coli* was present on culture, and although these figures are too small to carry any weight, they are at least suggestive that both pyelitis and cholecystitis are but part of one disease, a chronic *B. coli* septicæmia.

As to why women should be more prone than men to become thus infected is not clear. Pregnancy may be an important factor. Naunyn⁷⁸ first showed that 90 per cent. of all cases of gall-stones in women had been pregnant—figures which are closely in accordance with those of this series, 324 out of the 347 cases having been married women. The results of examination of various urines as recorded by Dudgeon²⁶ are of great interest from this point of view. The urines obtained from normal men contained in no instance any *B. coli*. From 20 cases of constipation it was obtained twice, from 20 cases of peritonitis four times, and from 45 cases of pregnant women ten times, showing the greater tendency of pregnant women to *B. coli* bacilluria.

Pregnant women are also prone to suffer with an infection of the kidney usually described as "pyelitis of pregnancy," which condition is usually due to the *Bacillus coli*. Thus Ward¹⁰⁷ found this organism present in 44 out of 56 cases, and Macaigne,⁵⁸ Brewer,¹² and French⁸¹ have shown that here also the organism probably reaches the kidney from the blood stream.

Another factor which may be of some importance is the much greater frequency of constipation in women, thus aiding in the absorption of the organisms from the intestine. In cases of gall-stones constipation is so frequent as to be noted in nearly all text-book descriptions of this disease.

When once the bacilli have gained access to the gall-bladder, any condition leading to stagnation of the bile could aid them in obtaining a foothold therein.

SYMPTOMS OF CALCULI IN THE GALL-BLADDER.

In a certain number of cases gall-stones may exist in the gall-bladder and give rise to no symptoms. Formerly this was believed to be quite common because many cases were discovered to have calculi post mortem, when no history of colic or jaundice had been obtained during life. Since Moynihan⁷⁴ and Mayo Robson,⁶³ however, have laid so much stress upon the fact that such symptoms only occur late, it is realized that many of these patients have had earlier symptoms which had been overlooked, and thus all these statistics become valueless. Probably very few patients are quite free from all symptoms, although it is undoubted that they may be free for many years. Thus cases may be admitted to hospital with severe cholecystitis due to the presence of many or large calculi, and only complain of a sudden onset of symptoms a short time previously. Although the calculi must have been present for months or years, no history of the earlier symptoms can be obtained. In other cases extensive chronic changes may be present in the gall-bladder, and a calculus may even ulcerate through into the intestine, and although, after the condition has been made clear the patient

may be closely examined as to the presence of past symptoms, in some cases no note of any such can be obtained.

In this present series there were 28 cases in which no symptoms whatever had been noticed until the onset of some acute complication, such as acute cystitis, rupture, impaction of the calculus in the cystic or common ducts, or acute intestinal obstruction. In each case the condition found at operation was such as to suggest that the calculi must have been present for a long time previously, and yet the patient denied any of the earlier symptoms which would have been expected.

In uncomplicated cases of calculi within the gall-bladder the most constant symptom is pain, of which, as Moynihan⁷⁴ points out, there may be two varieties.

Local Pain.—This is usually described by patients as indigestion, attacks of biliousness, or windy spasms. They complain of a dull aching or gnawing pain in the epigastrium and right hypochondrium, coming on soon after food. With it there is a sense of fulness and of having eaten too much, often accompanied with flatulence and actual distention, so that the clothes have to be loosened in order to obtain relief. In some cases there may be tenderness in the epigastrium and hypochondrium. The symptoms are generally relieved by the eructation of wind or rarely by vomiting. In such cases the condition may closely simulate gastric disease, especially as the symptoms, as Moynihan points out, may vary with the nature of the food taken.

In many cases this pain may exist for many years as a typical dyspepsia to be followed later by more severe symptoms. In this present series 185 cases gave this symptom as the earliest noted, although in seven cases only was it the only evidence of calculi. In the majority of cases it had existed for years, but treatment was not sought until other evidence of the disease had arisen. In three cases alone did this symptom appear later, that is after other signs of the condition had become manifest.

Of the cause of this symptom there is some doubt, but the

fact that the pain comes on shortly after food, that it only lasts a relatively short time and is relieved by vomiting or a decrease in the tension of the stomach, is suggestive of the fact that it is dependent upon dilatation of the gall-bladder by the physiologically increased flow of bile, the normal painless filling of the bladder being prevented by the presence of the calculi. It is probably increased by the contractions of the gall-bladder occurring with digestion. This belief is supported by the fact that in the seven cases having no other symptom, the gall-bladder was normal in appearance, showing no adhesions or macroscopical inflammatory change.

Diffuse Pain.—In these cases the pain is more severe, it is constant, but is subject to severe exacerbations after meals. It may arise as the earliest symptom or occur as a sequela to the last described condition. In a typical case the patient will describe attacks of severe pain in the right hypochondrium and epigastrium, radiating to the back and one or other shoulder, most commonly the right. At times it may pass over to the left side or to the right iliac fossa. As a rule the pain comes on in attacks which may last for a week or more, during which time it is constant, but likely to be increased by taking food. Although severe the pain is bearable and not to be confounded with the agony of true colic. With the attacks of pain there is vomiting, often of bile-stained material, headache, and a feeling of general ill health. The skin may be cold, and slight shivering attacks not sufficient to amount to rigors be present. Such attacks may often be described by the patients as severe bilious attacks. In some cases the pain may be worse at night and may be relieved by food, when a duodenal ulcer is closely simulated, and in fact a differential diagnosis may be impossible.

With the attacks of pain there is usually tenderness of the gall-bladder, so that if the patient be directed to take a deep breath there is a sudden deep stabbing pain in the right hypochondrium associated with a "catch" in the breathing. The best method of eliciting this tenderness is that suggested by Murphy.⁷⁷ The surgeon's fingers are hooked up deep be-

neath the right costal margin and the patient instructed to take a deep breath. As the tender gall-bladder impinges upon the resisting fingers, the inspiration suddenly ceases as though it had been cut off.

In some cases the upper right rectus may be distinctly rigid, and deep tenderness be at once obtained in the right hypochondrium. The pain then may be even more diffuse and pass down the right arm or be most marked in the right iliac fossa, so that the condition may be mistaken for appendicitis, although it must be remembered that there is at times an association of these two conditions as pointed out by Ochsner,⁷⁹ MacCarty and McGrath.⁶⁰

Often there is an area of superficial tenderness on the right side behind at the level of the twelfth dorsal vertebra and two to three fingers' breadth from the spine. This sign was first described by Boas.¹¹ He states that this area of superficial tenderness is present in the majority of cases, and if present in the acute attack is invariably found in the intervals, but if absent in the acute attacks it is absent in the intervals.

In 117 cases of this series this was the first symptom of which the patient had complained, while in 71 cases this more severe diffused pain only appeared after the patient had complained of dyspeptic pain for some years. In two cases it was only noticed after several attacks of colic and jaundice.

The facts that these symptoms are likely to occur in severe attacks superadded to the constant pain, that there is local tenderness with rigidity and referred pain, that there is general malaise, and that the symptoms are almost identical although not so constant as those found with some cases of suppurative cholecystitis are very suggestive that the condition is due to chronic or subacute inflammatory changes in the gall-bladder. In nearly all the cases in the above series it was noted that the gall-bladder was inflamed, adherent, or fibrotic and contracted.

(To be continued.)

**SOME MODIFICATIONS OF TECHNIC IN THE SUR-
GERY OF THE GALL-BLADDER AND
BILE-DUCTS. ***

BY JOHN E. SUMMERS, M.D.,

OF OMAHA, NEB.

EXPERIENCE to date has developed successful lines of surgical procedure in the operative technic of cholecystostomy, cholecystectomy, choledochotomy, cholecystenterostomy, and several rare operations on the gall tracts. In my judgment, when the most reliable life-saving operations are to be chosen, sufficient importance has not been placed upon, first, the condition of the patient at the time of operation, and, second, the local findings after the abdominal incision has been made. The writer published eleven years ago in the *Philadelphia Medical Journal*, a technic for cholecystostomy which had in principle the formation of a channel for drainage, lined by peritoneum (a continuous peritoneal drainage route). For several years prior to this publication, I had found by following out this principle that the danger of a fistula was avoided in all cases when the route to the duodenum via the cystic and common bile-ducts was free. Formerly it was not an infrequent experience that, like an intestinal fistula, the mucosa of the gall-bladder became attached to the abdominal incision, like the mucosa of the intestine, so as to cause a similar fistula.

The technic which I published and illustrated in 1900 is that generally advised by text-book writers; some few modifications have been made: Drs. Mayo, in Keen's "Surgery," vol. iii, p. 1017, illustrate and describe my technic, as modified by a purse-string suture. The original technic is well illustrated in Jacobson and Rowland's "The Operations of Surgery," vol. ii, and also by Binnie. I have called attention to this technic because it is the one in use to-day by most sur-

* Read before the American Surgical Association, June 21, 1911.

geons, but too few seem to realize its limitations, at least their writings and my observations of their work have so impressed me. There are contraindications to the attempted employment of the usual technic of cholecystostomy, when from the situation or size of the gall-bladder it is impossible to sew it to the parietal peritoneum without loosening the peritoneum on each side of the abdominal incision, so that these flaps of peritoneum can be depressed and attached to the gall-bladder. This technic (introduced by Mayo Robson), although in some cases practicable, is never a wise procedure because it results in the formation of painful and maybe dangerous adhesions; it is entirely unnecessary. If the drainage tube is properly fastened into the gall-bladder, nature, in a few hours, protects the tract of the drainage tube by limiting adhesions. A cigarette drain may be employed to still further establish a protective route for the drainage tube, and a gutter of omentum may be arranged as a further protection.

Whenever the gall-bladder walls are infiltrated so that a safe and easy invagination of them is difficult, no attempt in this direction should be made. Many surgeons under such circumstances sew a drainage tube into the gall-bladder and then sew the gall-bladder to the peritoneum of the abdominal incision. There is danger that a fistula may follow this technic—I have seen such results. My practice is, first, to excise the mucosa of the gall-bladder for a half to three-fourths of a centimetre around the periphery of the incision into it, and then fasten the drainage tube by a securely tied purse-string catgut suture introduced so as to exert sufficient pressure upon the mucosa beyond its excised border; this not only secures the tube and prevents hemorrhage, but also eliminates the mucosa in such a way as to prevent the formation of a fistula.

When infection is a marked feature of the contents of a gall-bladder, and its walls are thickened and œdematous, none of the methods of technic already described are suitable or safe. The object of treatment in such an instance is to provide drainage with the least trauma to the integrity of the gall-bladder walls, more especially to the mucosa, which may in

greater or lesser part be necrotic. Whenever possible, the soft adhesions surrounding such a gall-bladder should not be disturbed—rather one or more gauze packs may be introduced to still further insure the localization of the infection. The gall-bladder must be freely incised, and, if easily done without tension, sewed to the abdominal incision and drained with a tube. If tension would follow such suturing, introduce and fasten by a suture a good sized rubber tube into the gall-bladder, and by cigarette drains and gauze packs completely circumscribe the infected gall-bladder.

In the absence of infection cholecystectomy is a justifiable operation. An old contracted gall-bladder containing a calculus, may better be removed. Hydrops of the gall-bladder from an impacted calculus in the cystic duct or a stricture closure of the cystic duct may best be treated by cholecystectomy, compensation by hypertrophy of their walls and enlargement of their lumen having taken place in the hepatic and common ducts. However I must take issue with those who advise cholecystectomy in any acute infection within the gall-bladder extending into or beyond the cystic duct. Likewise I feel confident that more lives will be saved and fewer complications follow by avoiding cholecystectomy when infective inflammations are apparently confined to the gall-bladder, especially so, should there be gangrene of the gall-bladder.

All acute infections of the gall-bladder, empyema, gangrene either involving the mucosa alone or the muscular walls and peritoneum should be treated by simple incision and drainage after a protective gauze packing off of the peritoneal cavity. I have known disaster follow cholecystectomy in such cases—the crushing of the cystic duct and its artery, more especially of the poison laden lymphatics; the trauma to the peritoneum passing from the gall-bladder neck to the gastro-hepatic omentum, can and does in some such instances lead to a thrombophlebitis and fatal infections. In two cases I know of, there was sloughing of the stump of the cystic duct, destroying it so that the biliary fistula resulting communicated directly with the hepatic duct. Had the operative in-

terference been limited to free incision into the gall-bladder after gauze packing, the gangrene would probably not have extended; tension would have been relieved and had not nature brought about a cure the patient's improved general condition would have admitted of some one of the several plastic procedures being carried out. The removal of gall-stones from an infected gall-bladder should be done with great gentleness. In fact at times it is much wiser not to attempt their removal until the circulation is better established by the relief of tension following free incision of the gall-bladder fundus. The spooning out of gall-stones is always accompanied by more or less trauma to the mucosa of the gall-bladder, thereby in seriously infected patients opening up fresh foci for attack by the invading germs. The expression of enough of the stones through a free incision into the gall-bladder fundus by passing the fingers of one hand under the gall-bladder and raising it up against the under surface of the liver or against the fingers of the other hand as indicated, will limit trauma, reduce tension, and admit of temporary drainage. In these instances if the common duct is enlarged considerably and the gall-stone history of relatively long standing, this enlargement may not be a compensatory change, but one due to an impacted stone in the lower end of the common duct, and this duct should be incised and drained. I have the notes of a number of patients, teaching the wisdom of the practice advised, and I have seen death follow the more ideal technic. One particular fact has been impressed upon me: whenever upon incising an infected gall-bladder of a very ill patient, there is a foul odor to its discharging contents, no further trauma should be inflicted within the gall-bladder. If in such a case it is possible to reach the cystic duct it should be incised.

Open drainage and protective gauze packing are the best life-saving measures—these are emergency operations, and it is wonderful how seldom secondary operations are required.

Years ago in an emergency, I made an anastomosis between the common bile-duct and the duodenum; there was a stricture

of the cystic duct and also of the duodenal end of the common duct. The patient recovered.¹

The anastomosis of the gall-bladder to the duodenum or other parts of the bowel is usually readily feasible and valuable in obstructions in the common duct and in chronic pancreatitis. Its exact position in the latter condition is not determined, but I am personally convinced of its value; if the temporary drainage of cholecystostomy is of value in the treatment of chronic pancreatitis, then the permanent drainage by cholecystenterostomy must be doubly so. When cholelithiasis is a complication of pancreatitis, the drainage should always be external, and possibly will be favored by the repeated forcing of water through the ducts into the duodenum as recommended by MacArthur. Likewise such treatment, cholecystostomy and duct washings, may be advisable whenever cholecystitis is a prominent symptom as a complicating or relapsing factor of typhoid fever. This surgical procedure should only be employed after the failure of vaccines. New infections may occur through the nurse taking care of typhoid patients not using proper "surgical" precautions, as the wearing of rubber gloves, etc. "The route from the bed-pan and urinal to the food tray is a short one." I have had made for me and use horse serum, each 10 c.c. containing 10 grains of calcium lactate, which I believe has been as a prophylactic measure of service in preventing possible hemorrhage in cholæmic cases.

¹ Journal of the American Medical Association, March 10, 1900.

MESENTERIC CYSTS.

WITH REPORT OF A CASE.

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AND

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THE following is the report of a case which has come under our observation, together with a résumé of the literature on the subject as regards the etiology, symptomatology, diagnosis, and treatment of mesenteric cysts.

CASE I.—E. H., aged eight years, female, was admitted to the Hebrew Hospital on October 23, 1910, complaining of pain in the abdomen and across the back.

The *family history* is interesting from the standpoint of neoplasms, her grandmother having died from cancer of the stomach, and her mother having had a tumor of the breast, which was removed when she was twenty-five years of age and which has not recurred.

Her *past history* is unimportant, except for the fact that she has been troubled with constipation and abdominal discomfort for several years.

Present Illness.—About two years ago patient began to complain of severe abdominal pain, especially at times when she was constipated, which was relieved by enemata or castor oil. At first these attacks of constipation with severe abdominal pains would occur about once every two weeks, but they have gradually become more frequent until at the present time, when they occur daily. Several months ago patient was in bed for three weeks with severe abdominal pain and vomiting, the vomitus being blood stained. She described the pain as severe and sharp, and states that she has a constant aching in her abdomen at all times. Has lost weight in the last year.

Physical Examination.—On physical examination patient found to be fairly well nourished, expression and color good. Examination negative except for abdomen. Just to the left of

the umbilicus a large mass could be seen. On palpation this mass was found to be movable and could be pushed from side to side or higher up in the abdomen, and apparently was the size of a cocoanut. The liver and spleen were not palpable, and there was no rigidity or tenderness made out except upon firm pressure over the tumor-like mass.

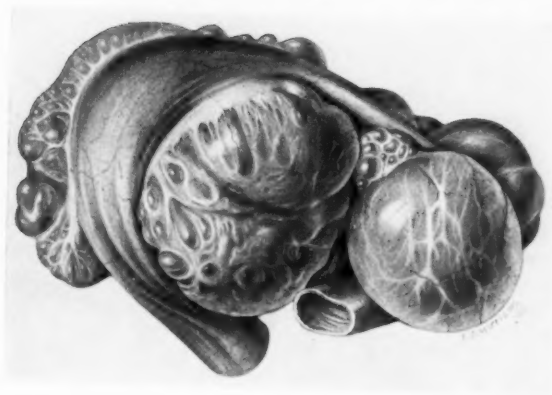
Operation.—Under ether anæsthesia abdomen was opened by a median incision, extending from an inch below the umbilicus to the pubes. After cutting into the peritoneum a cystic tumor about the size of a cocoanut jutted into view. The mass was multilocular, each lobe in itself being made up of many lobules. The tumor was located between the layers of the mesentery, about the middle of the ileum. Intestinal clamps were placed on the bowel on either extremity of the growth. The intestine was then cut external to the clamps, and the mesentery cut and clamped external to the growth. All bleeding vessels were ligated, and an end-to-end anastomosis performed. One small cigarette drain was inserted in lower part of the incision and the patient left the table in good condition.

Patient made an uninterrupted recovery, bowels moving three days later and drain removed four days after operation. She left the hospital twelve days after operation, cured. Her bowels moved daily and there was no abdominal discomfort whatsoever. She was seen four months after the operation when she was perfectly well. Had gained 30 pounds.

The growth involved practically the whole mesentery of the ileum and apparently originated close to the intestinal margin. It consisted of two cystic masses with a sulcus extending between them close to the bowel—the larger cyst mass involving 5 inches of the bowel and the smaller 3. The greatest circumference of the larger cyst mass was 9 inches and that of the smaller 7. The circumference at the sulcus between the two masses was 5 inches. The whole growth weighed 13 ounces.

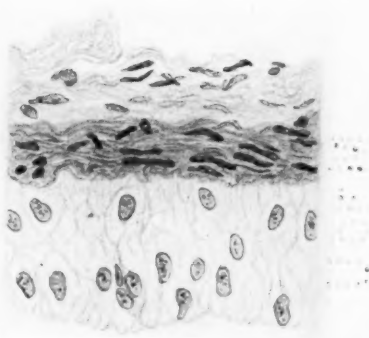
The bowel measured 8 inches and the cut free mesenteric border 4 inches, which necessitated fixation of the bowel and caused moulding in a circular manner around the cyst. The bowel over the larger cystic mass was completely flattened owing to the tension produced upon it by the growing cyst, the cystic mass extending well out on either side of the bowel for at least two inches. The smaller cystic mass consisted of two cysts the

FIG. 1.



Mesenteric cyst together with resected bowel.

FIG. 2.



Microscopic section of cyst wall, showing lining of cylindrical epithelium.

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size of hen eggs on either side of the bowel. These cysts were opened to obtain the fluid for examination and were found to communicate in the median line close to the bowel margin.

The walls of the cysts were thin, shiny, translucent membranes, and showed definite lines of smaller cysts within. The growth was so arranged that it could have easily become twisted upon itself with the bowel, where the two cystic masses met as a centre, and thus caused obstruction. This, no doubt, was the origin of the severe vomiting spells described above. A few small blood-vessels were noted traversing the cyst walls. One cyst at the junction of the larger and smaller cystic mass had a much thicker wall and was firmer than the rest of the cysts, and was the size of a pigeon's egg.

Sections were made from the larger and smaller cysts. Their walls were composed of fibrous tissue containing a few small cells, blood- and lymph-vessels. On their inner surfaces there were epithelial cells which were columnar in type, the protoplasm staining very little but the nuclei staining very well. Some of the nuclei were lying close to the basement membrane, but others were close to the secreting surface of the cell.

It is interesting to note that the contents from the minute cysts were gelatinous, and clear, while that of the larger cysts was watery, milky, opalescent, and bluish. On allowing the same to stand a shimmering deposit appeared on the surface. This proved to be, on microscopical examination, showers of cholesterin crystals. The total quantity of fluid removed was 115 c.c. The specific gravity was 1.016, and its reaction was neutral. The following were found on microscopical examinations: showers of cholesterin crystals, fatty acid crystals, fat cells, leucin globules, degenerated epithelial cells (some with and some without yellowish pigment), and fat droplets, which had the characteristic stain with soudan three. The total albumin was 14 grammes to the litre. The chemical tests were made for pseudomucin, but this constituent was lacking.

The appearance, microscopical and chemical analyses of this structure would at once remind one of the cystadenoma of the ovary, except for the absence of pseudomucin which is thought to be an important factor in these growths. The structure of the cystadenoma of the ovary consists of multiple cysts which are lined with columnar epithelium. The contents of the smaller cysts are gelatinous and clear, as described in the smaller cysts of this growth, and the larger ones are liquid and cloudy, as in the larger ones of this growth.

When we consider that up to the present time there are about 200 mesenteric cysts in all reported in the literature, we can well make the statement that they are amongst the surgical

rarities. The first record we have is of a case reported by Benevieni in 1507 which he found at autopsy. Indeed up to 1850 all cases reported were found at post mortem.

The history of mesenteric cysts has been divided by Braquehay into three periods: First, the period commencing with Benevieni and extending to 1850, consisting solely of cases recorded at autopsy; second, from 1850 to 1880, during which time operations were occasionally performed for the removal of mesenteric cysts, but usually after an incorrect diagnosis, these cases generally terminating fatally; third, from 1880 until 1900, during which time interesting and helpful discoveries resulted in having the cyst diagnosed and operated upon successfully. We can very well add to the classification of Braquehay a fourth period commencing at the time of Dowd's interesting theory, "the origin of mesenteric cysts from embryonic sequestration," and extending to the present day.

The most important workers in this field have been Portal, who classified them as early as 1803; Braquehay, who in 1892 reported 104 cases of mesenteric cysts and classified them as follows: (1) sanguineous cysts or hæmatomas; (2) lymphatic cysts; (3) parasitic cysts or hydatids; (4) congenital cysts or dermoids; (5) cysts of joining organs, such as ovarian, parovarian, and pancreas; and Moynihan, who, in a very comprehensive article in 1897, also classified them as follows: (1) serous cysts, (2) chyle cysts, (3) hydatid cysts, (4) blood cysts, (5) dermoid cysts, (6) cystic malignant disease. In 1900 Dowd expounded a logical theory for the origin of mesenteric cysts, and based a classification on this theory which is more tenable than either of the previous classifications, his being as follows: (1) embryonic cysts, (2) hydatid cysts, (3) cystic malignant disease.

ETIOLOGY.

The etiology of these tumors is at present an unsettled matter, there being two schools,—Braquehay-Moynihan-Porter and their followers, who adhere to the theory that mesenteric cysts are of multiple origin; and Dowd, who

claims that they are of embryonic origin, this being a modification of Cohnheim's theory.

Dowd states that in the development of the Wolffian body it is probable that portions of the germinal epithelium of some of the organs are separated and carried between the layers of the mesentery in the development of the alimentary canal. In later life these cells become activated and take on new growth. The fact that in the growth of various organs, such as the liver, suprarenal, lung, spleen, pancreas, and thyroid, accessory lobes are frequently found far from the organ itself is an argument in favor of this theory. Up to 1900 very little work had been done as to the origin of mesenteric cysts, no cyst wall had been examined microscopically, nor contents chemically. Dowd made tests and sections of a cyst and its contents and was struck by their marked similarity to the cystadenoma of the ovary and its contents. Since then a number of cases have been reported in which, after careful examination of their walls and contents, the tissues similar to those found in various organs of the abdomen have been found.

VARIOUS FORMS OF MESENTERIC CYSTS.—*Blood Cysts.*—These cysts have been reported from time to time. Frequently a history of injury could be obtained from patients having sanguineous cysts, and these cases were, of course, suffering with simple hæmatoma. They are usually preformed cysts in which hemorrhage has occurred. The majority of mesenteric cysts are well supplied with blood-vessels and one can easily conceive how one of the inner vessels could rupture and produce hemorrhage within the cyst wall. According to Dowd's theory these cysts could well come in the class of embryonic cysts.

Dermoid Cysts.—A few dermoid cysts of the mesentery have been reported. Dermoids occurring in the abdomen have generally been considered ovarian in origin. According to Cohnheim they are ectodermal inclusions during fetal life and the growth of these elements at a later time. Langton reports a case in which both ovaries were involved with dermoid cysts and a similar structure found between the layers

of the mesentery. It is interesting to note that all mesenteric dermoids reported have occurred in females. Dermoids, therefore, are no doubt of ovarian origin.

Chyle Cysts.—This class constitutes the most common of mesenteric cysts. They contain a milk white fluid, and the microscopical appearance shows granular cells, some of which have undergone fatty degeneration, and the walls of the cysts are usually fibrous and firm. It has been supposed that these cysts are due to the dilatation of some of the lacteal or chyliferous vessels. It has also been suggested that there has been an effusion of chyle into previously existing cysts. We can well understand how a duct which has a gland behind it might become cystic if it were occluded. Demons reports a case of multilocular cyst in which one compartment contained blood and the other chylous fluid. Kuster described a chyle cyst which was lined with epithelium, a lining which could not have existed in a dilated lymph vessel. Ducasset reports a chylous cyst in which some lobules contained yellowish serous fluid with no evidence of chyle and others contained white chylous fluid. There are a few cases of chylous cysts reported, which had their origin in the dilatation of the receptaculum chyli. Miles Porter states that chyle cysts have various origin, and that nothing is common with them except their contents and location. "Microscopically glandular epithelium will be found in cysts originating in the degeneration of lymph-glands and endothelium in those originating from dilatation of lymph vessels, providing atrophy of these elements has not resulted from pressure." According to Dowd the various forms of chyle cysts are preformed embryonic cysts in which chyle has effused.

Hydatid Cysts.—Hydatid mesenteric cysts form a class distinct and separate by themselves, as they are due to a specific cause, the growth of the *Tænia echinococcus*. There are quite a number of cases reported in the literature. The hooklets or the peculiar laminated structures of the cyst walls have been described from the microscopic sections of the cyst.

Cystic malignant diseases of the mesentery have been reported, some representing a metastasis from other organs, and several cases primarily occurring between the layers of the mesentery are on record.

Gas Cysts.—The gas cysts described by Dr. J. M. T. Finney are really not mesenteric in origin, and cannot be put in our classification.

Serous Cysts.—These cases have been referred to by many observers, but the lines of classification are not very well marked, and embryonic cysts such as Dowd's and the ones described below are most likely the serous cysts of the old-fashioned classification.

There are several cases reported in the literature which suggest that the cysts are of embryonic origin from different structures. I. Walker Hall reports a case of a boy, fifteen years old, in whom the cyst consisted of all the layers of the stomach, but it had no connection with the stomach, which was normal as regards position and relation. Fran Van Der Bogert reports a case in a girl, five years old, with the arrangement and structure of the cyst wall similar to that of the intestine. Dowd also mentions a case reported by Eve of a cyst removed from the mesentery of the jejunum, which had three layers of unstriated muscle-fibres within its wall; another by Fehleisen describing a multilocular cyst whose wall contained three layers, an outer connective tissue, and an internal layer of exclusively unstriated muscle-fibre; and another by Bretano of a mesenteric cyst in the walls of which smooth muscle-fibres were found under the serosa. These cases naturally make one think that they are due to a sequestrum of a portion of the bowel.

It is very interesting to note that, besides the connective tissue, fat, lymphatic vessels, glands, and blood-vessels lying between the mesentery, a few fibres from the muscle of Treitz and some of the radiating muscle-fibres of Rouget derived from the two pillars of the diaphragm are present, as well as certain congenital remnants of the Müllerian and Wolffian ducts and bodies.

SYMPTOMATOLOGY AND DIAGNOSIS.

The most important symptoms of mesenteric cysts are: an abdominal tumor, frequently located centrally, freely movable, and in the female not connected with the ovary, fluctuation of the mass being frequently elicited; obstinate constipation of increasing intensity; severe abdominal pain, relieved by defecation; and a continual abdominal discomfort. Volvulus occurs frequently from twisting of the growth upon itself, thus kinking the bowel. Vomiting is very important, being frequently the symptom of a partial obstruction. Emaciation is often present, but this is not necessarily due to interference with the lacteals, inasmuch as cases are on record in which large portions of the small bowel have been removed without disturbance of nutrition. Emaciation is probably due to constipation and pain. Age is of no significance, cases having been reported varying in age from eleven weeks to eighty years. Mesenteric cysts are more common in women than in men. Puny development is characteristic in these growths.

The cardinal symptoms are therefore as follows: pain, constipation, fluctuating movable mass in region of the umbilicus, and loss of weight. Some growths, however, especially the smaller ones, present no symptoms whatsoever.

TREATMENT.

No specific rule can be laid down as regards treatment, each case necessarily having to be treated differently, varying on the location and size of the growth and the condition of the patient. Surely every diagnosed case should be operated upon. If the cyst has a definite pedicle it should be ligated and the growth removed, but if there is no pedicle the cyst should be enucleated. If the growth involves the mesentery in such a manner that the involved portion is very broad and its whole width from bowel margin to the posterior abdominal connection is involved, a resection should be performed, as enucleation would possibly disturb the blood supply of the bowels. The method of resection would depend upon the

judgment of the surgeon. Some cysts are so large and so situated that enucleation or resection is out of the question. In these cases an incision should be made into the growth, and drains inserted. These patients drain from four to twelve weeks, but the fistula will finally close.

The most serious complication of these cysts if not operated upon is intestinal obstruction. A number of cases are reported in the literature from this cause. As the growths increase in size, pressure is brought to bear upon the involved bowel centrally and laterally by the lateral growth of the cyst. This central pressure and lateral tension flatten out the bowel so completely that it is with difficulty that anything can pass through it. Volvulus is also an important cause of obstruction in these cases.

In conclusion, we wish to extend our sincere appreciation to Dr. B. M. Edlavitch for his helpfulness in the pathological portion of this work.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, Held March 6, 1911.

The President, DR. ROBERT G. LECONTE, in the Chair.

DR. ASTLEY P. C. ASHHURST presented four patients, three from the service of Dr. Chas. H. Frazier in the Episcopal Hospital, and one from the service of Dr. R. H. Harte in the Orthopaedic Hospital.

I. AMPUTATION OF LEG BY THE METHOD OF BUNGE.

By the usual methods of amputation, in which no attempt is made to secure an end-bearing stump, the patient is compelled to wear an artificial leg with an inner socket, and to bear his weight almost entirely on the tuberosities of the tibia. This results in a certain amount of *give* at each step, producing decided disability from a lack of elasticity in the gait, even if there is no marked limp. To overcome this disability, and to secure a stump on which the patient can bear his entire weight as he does normally on his foot, Bier (*Deutsch. Zeit. f. Chir.*, 1892, xxxiv, 436; *Arch. f. klin. Chir.*, 1895, I, 356) devised his osteoplastic method, analogous to that of Pirogoff at the ankle, or of Stokes and Gritti at the knee. Bier's method appears to have been practiced by various surgeons in this country, and has found its way into many text-books of operative surgery; but the much simpler method of Bunge, of Königsberg, seems to be little known. This method was described at length in 1905 (*Beit. z. klin. Chir.*, 1905, xlvii, 808), when the histories of twelve patients were reported. It was proposed on the theory that the tenderness of stump is due to little islets of new formed bone, derived from shreds of periosteum or from marrow cells displaced at the time of operation. Bunge argued that if those could be prevented from developing, and if the bones were to be covered only by a flap of skin, conditions

closely approaching the physiological would be present. Accordingly, his proposition involved not only discarding the periosteal flap, but even sawing the bones 2 mm. below the level at which the periosteum was divided, and then scraping out the medulla of the bones for several millimetres above the level of section. This method was used by Dr. Ashhurst in the case of Edward S., aged forty-seven years, who was admitted Nov. 25, 1910, to the service of Dr. Frazier, in the Episcopal Hospital, for crush of the right foot. Amputation was done five hours later, as soon as the moderate shock present on admission had passed off.

An Esmarch band was applied above the knee; long anterior and a short posterior skin flaps were formed, in the lower third of the leg. The muscles were divided circularly down to the bones at the base of the skin flaps. The periosteum was divided circularly at the same level. Then the periosteum and muscles *below* the section were dissected with most meticulous neatness from the shafts of tibia and fibula, thus absolutely denuding these bones of all tissue for a distance of an inch or more below the level at which the muscles and periosteum had been divided circularly. Then the bones were sawed about one-eighth of an inch *below* the line of section of periosteum and muscle, the fibula being sawed off first, and a little higher than the tibia. Then the medulla of both tibia and fibula was scraped out with Volkmann's sharp spoon for about an eighth of an inch. After ligating the vessels, the Esmarch band was removed, and the skin flaps closed with interrupted silkworm gut sutures, a small rubber drain tube emerging at the outer angle of the incision. This tube was removed on the third day, November 28, without disturbing the deep dressing.

November 30: Light tapping on the end of the stump gave no pain. This tapping was gradually increased in force at each daily visit, never causing any pain; the patient merely acknowledged that he felt it, even when the tapping had increased to a severe thumping with the heel of the surgeon's hand.

December 5: First dressing. Sutures removed. Incision completely healed.

December 10: Patient can now bear without any discomfort all the pressure which can be brought to bear by the surgeon's hand directly on the face of the stump, through thin gauze dressings, so long as this pressure is not suddenly applied.

December 16: Three weeks since amputation. Can stand momentarily on stump, without pain, and with only slight support to hands to maintain balance, and with good leg swinging free of the floor.

December 20: Twenty-five days after amputation the patient was photographed standing on a chair on his stump, balancing himself with his hands on the back of the chair, and his other leg hanging free in the air.

The subsequent conduct of the patient was discouraging. He was discharged from the Episcopal Hospital with directions to apply to the Orthopædic Hospital, where, in the service of Dr. G. G. Davis, it was proposed to have him provided with an artificial leg made to permit use of his end-bearing stump. Within two days, however, of his discharge from the Episcopal, he ordered from another source an ordinary type of artificial leg, with all the weight borne through an inner socket taking its bearing on the head of the tibia; and he merely came to the Orthopædic Hospital to inform his surgeon that the man who made his artificial leg told him that an end-bearing stump was a surgical impossibility; and even though this leg maker had ocular evidence to the contrary, because the patient showed him how he could stand on the end of his stump, yet the leg maker argued that as he had never seen any other stump which could bear the patient's weight, he could not make any other kind of artificial leg than he was in the habit of making.

II. CONGENITAL ELEVATION OF LEFT SCAPULA.

John S., now aged three and a half years, was admitted to Dr. Harte's service at the Orthopædic Hospital Oct. 1, 1908, at the age of 17 months. He was so weakly at this time that it was thought unwise to institute any very active treatment for the deformity, which was very marked. The child could not sit up, but doubled up constantly to the left side. A year later, Oct. 7, 1909, he was admitted to the ward, and kept in bed with head and foot extension for two months, and was discharged Dec. 20, 1909, wearing a scoliosis brace, with head support, and with noticeable improvement in his deformity. He was readmitted for operation when three years old Aug. 4, 1910.

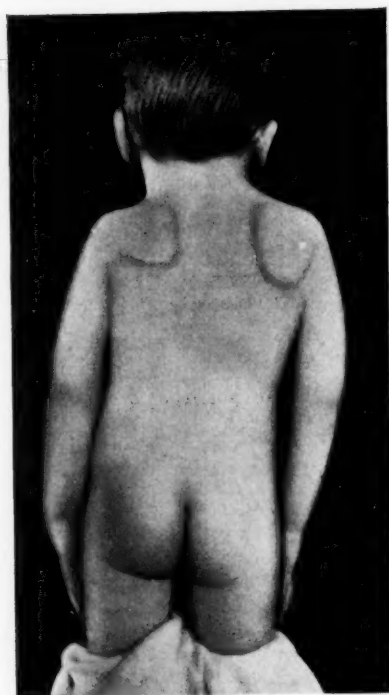
Examination (Aug. 4, 1910).—Head falls to left shoulder, and cannot be brought straight. There is scoliosis, convex to

FIG. 1.



Congenital elevation of left scapula, before operation.
(Case II.)

FIG. 2.



Congenital elevation of left scapula, three months after operation. (Case II.)

right in dorsal and to left in lumbar region of spine. Skiagraph shows absence of left fourth rib; left third rib is rudimentary, terminating a short distance from the vertebral column. Left second rib is very prominent at costal cartilage, and bends sharply backward across inner wall of axilla. Several skiagraphs showed no evidence of cervical rib. Left arm is not used properly; supination of forearm is not quite complete; external rotation of humerus is normal in extent. Humerus can be abducted to 90 degrees, and then further elevation is checked by scapula which cannot rotate. Muscles: Pectoralis major, trapezius, and deltoid present; tense band of trapezius runs from occiput to scapula. Left latissimus dorsi apparently is absent. Supra- and infraspinatus present. Left arm can be abducted across patient's back until elbow touches angle of right scapula. Right arm can be abducted across back only until it makes an angle of 10 degrees to left of a sagittal plane passing through right shoulder. Scapulæ: Left scapula is considerably higher than right, which is normal.

Left Scapula.	Right Scapula.
From vertebral border to acromion, 7 cm.	From vertebral border to acromion, 6 cm.
Length of vertebral border, 6 cm.	Length of vertebral border, 8 cm.
Scapula extends from 5th cervical to 2d dorsal vertebra.	Scapula extends from 1st dorsal to 6th dorsal vertebra.

Left scapula is rotated in frontal plane so that lower angle is only 1 cm. from vertebral spine and is immovably fixed there. (The above measurements were made through the soft parts of a chubby child, and therefore are only approximations.)

Operation (Aug. 8, 1910).—Ether, patient prone. Four-inch incision along vertebral border of left scapula; divided trapezius, which contained dense fibrous band running from occiput to upper border of scapula; divided levator anguli scapulæ; divided both rhomboids close to scapula, and excised a cartilaginous band attaching angle of scapula to spine of vertebra (this at once permitted free rotation of scapula in frontal plane); there then remained a few dense bands uniting subscapularis to thorax near angle of scapula, and

these were divided. The scapula was then depressed as much as possible, and the rhomboids were resutured to the upper angle of scapula, above its spine, thus rotating its lower angle away from the vertebral column. The wound was closed without drainage. No exostoses or cervical ribs were found.

Recovery was prompt, and improvement in the deformity and function of the left arm very marked. The child still wears his scoliosis brace, with head support; and owing to the congenital absence of two ribs it is not likely that he will ever be very straight. But he now holds his head erect, can put his left hand to his head, to the nape of his neck, and to the back of his waist. He seems to be still improving.

III. EXCISION OF URETHRA, WITH END-TO-END SUTURE.

Frank S., aged nine years, was admitted to Dr. Frazier's service at the Episcopal Hospital Nov. 1, 1909, having passed no urine for ten hours. His bladder was distended above the umbilicus. He gave a history of a fall two months before from a height of 3 or 4 feet, astride an iron bar; this was followed by ecchymosis locally, and temporary passage of blood-clots from the urethra. No further trouble was experienced until three days before admission. On admission a filiform bougie was passed with some difficulty, and by gradual dribbling of urine the bladder was emptied within 24 hours.

Though the filiform remained in place, it never was found possible to pass a Gouley catheter over it. It was therefore decided to operate; and in view of the well-known difficulty of keeping traumatic strictures dilated if they are treated merely by incision, it was determined to excise the strictured portion of the urethra, and to suture the divided ends together; but if this was not possible it was proposed to insert a section of a varicose vein which was removed from another patient about that time and kept in salt solution ready for use.

Operation (Nov. 12, 1909).—A median perineal incision two inches long was made through Colles' fascia, exposing the bulb of the urethra. The bulbocavernosus muscles were then cleared by dissection on each side, until the superficial layer of the triangular ligament was bared. The urethra (still unopened) was then carefully dissected free from the corpora cavernosa, dense cicatricial tissue being

encountered close to the urethral canal just in front of the triangular ligament. The urethra was then cut across transversely in front of the strictured area (the filiform remaining in place as a guide), and the distal (bulbous) edges of the urethra were caught in mosquito forceps. The strictured area of the urethra was then dissected up through the superficial layer of the triangular ligament until healthy tissue was reached, when the urethra walls were again divided transversely, and the proximal (membranous) portion of the urethra was similarly caught in mosquito forceps to prevent its retraction. About one-half or three-fourths of an inch of the urethra was excised in all. To permit of approximation of the severed ends, the distal (bulbous) urethra was dissected loose for about an inch. A catheter was next passed into the bladder through the perineal wound, and the filiform bougie was withdrawn. A Mercier catheter was then introduced through the penile urethra into the bladder, and the first catheter withdrawn. The ends of the urethra were then united (first the roof and then the sides) with four interrupted sutures of chromic gut. A small wick of iodoform gauze was placed against the unsutured chink in the floor of the urethra, and the Mercier catheter was left in place, draining the bladder through the penile urethra. The perineal wound was closed around the gauze drain with interrupted sutures of silk-worm gut.

The time of the operation was one hour; owing to the scar tissue and the diminutive size of the parts in a small boy of nine years, it was a rather tedious dissection.

The urine drained well from the penile catheter, but on the fifth day this was found to have prolapsed through the perineal wound, and it was accordingly withdrawn. Thereafter most of the urine passed through the perineal wound, but there was no loss of control. Nine days after operation a No. 14 Fr. steel sound was passed with perfect ease; and this was repeated twice weekly for two or three weeks. Urine ceased to come through the perineum after two weeks, and the perineal wound was entirely healed in four weeks.

During January and February, 1910, Nos. 12, 14, and 16 Fr. steel sounds were passed once weekly; then at intervals of two weeks until April 20, when an interval of six weeks was allowed, until June 1. As Nos. 16 and 18 Fr. passed easily then, an inter-

val of four months was allowed to elapse; and as on October 8, 1910, nearly a year after operation, Nos. 16 and 18 Fr. passed with perfect ease, the patient was discharged. He has had no urinary symptoms since the operation, and to-day seems to be cured of his stricture.

IV. OSTEOTOMY OF RADIUS.

James McP., aged fifteen years, was admitted to the service of Dr. Frazier, in the Episcopal Hospital, Dec. 5, 1910, with very marked silver-fork deformity of the right wrist, following an injury received seven weeks previously, from a fall on the outstretched hand. The wrist had been dressed by his family physician for three weeks on a straight palmar splint with the forearm in full pronation. On admission, in addition to the deformity, supination was possible only to the mid-position, and the boy could not make a fist owing to inability to flex the proximal phalanges, though the distal and middle could be well flexed. There was a large bony mass projecting beneath the flexor tendons above the wrist. A skiagraph showed an unreduced epiphyseal separation of the lower end of the radius.

On December 7, the patient was etherized, and attempts were made to correct the deformity without operation, but without success. Osteotomy of the radius therefore was done about half an inch above the epiphyseal line. Most of the deformity then could be corrected, though the epiphysis of course was still in abnormal relation to the diaphysis. The arm was dressed in full supination on a Bond splint, well padded to maintain the desired position.

The progress of the case was uneventful, and four weeks later the patient could make a good fist; after six weeks all functions were perfect, and only very moderate deformity remained.

ACTINOMYCOSIS.

Dr. J. CHALMERS DA COSTA presented a patient in an early stage of actinomycosis, or, as he preferred to term it, streptotricosis. Until recently actinomycosis meant disease due to the ray fungus alone. Streptotricosis means a disease of man or animal due to one of the various forms of streptothrix. The manifestations of the disease probably differ in accordance with the forms of causative organism. If organisms of thread form are present

the surgeon can be reasonably sure of the diagnosis. If the threads are branched he can be certain of it. The ray fungus is seldom found in humans and is not invariably found in bovine streptotricosis. The appearance of the disease varies with the stage in which it is seen. A description of the surface appearance of an early stage would by no means fit a well-developed or an advanced case. The appearance is greatly changed by mixed infection with pyogenic bacteria. A severe secondary pyogenic infection may obliterate all appearances suggestive of streptotricosis, and in such a case it may be impossible to demonstrate the streptothrix. Certain persistent abscesses, particularly abscesses connected with the alimentary tract, are due to streptothrix infection and secondary infection with pyogenic bacteria.

Every now and then a surgeon sees a long persisting sinus heal under the administration of iodide of potassium. This event at least suggests that the original cause of the condition was streptothrix infection.

The patient was a man, sixty-two years of age, a native of New Jersey and a resident of that State. Until six weeks ago he was entirely well except for two carious teeth in the left upper jaw. There were no symptoms of antral disease. The teeth were pulled. An area of moderate tenderness developed under the orbit, accompanied by purple red discoloration of the skin. This discoloration spread over the left side of the face, little points formed which contained no "matter," and the lower eyelid became œdematous. The speaker lectured on this man before his class at the Jefferson Hospital and presented him as a case of streptotricosis. This diagnosis was subsequently confirmed by the microscopic findings.

In this patient the stage of sinus formation has not yet been reached. There was no sticky glutinous discharge containing sulphur-yellow granules, in fact there was no discharge at all. The line is irregular and the X-ray pictures which were shown exhibit two foci of disease. There was, in this case, a cutaneous lesion arising secondarily to osseous lesions.

The color of the purple-red area disappeared on pressure, rapidly at the margin, much more slowly at the centre. On the removal of pressure the color rushed back rapidly at the margin and much more slowly at the centre. In other words, there was hyperæmia at the margin and beginning stasis at the centre. The

surface may be described as an irregular area of purplish mottling. Each wave-like irregularity or projection was about one-third the size of the little finger-nail. Over the areas of the disease the surface was soft and tender, but individual nodules were not tender. The skin over the nodules was thin and glistening, as though about to vesicate, but there were no sinuses, and no pus ran out on incision.

If this case were not interfered with it would inevitably go on to sinus formation. Microscopic slides show staphylococci as well as actinomyces, hence sinus formation would be certain to arise. Out of each sinus glutinous purulent material would ooze, and, in a typical case, the material would contain yellow granules. In some cases in which such granules cannot be recognized in the pus they become visible by putting the pus in a test-tube with water and shaking the tube. Then the granules adhere to the side of the tube.

This was the fourth case Dr. Da Costa had seen of human streptotricosis. The first patient was a mattress stuffer, the second a physician, and the third a farmer. The patient shown was a railroad switchman. He had not been in contact with horses or cattle, did not handle hay or straw, and does not go into barns.

In only 10 or 15 per cent. of cases is it possible to trace such a close connection with grains as to make it highly probable that the causative organism was obtained from them.

Dr. JAMES K. YOUNG called attention to a case reported in the American Orthopædic Society Proceedings occurring in a patient of thirty-five years who had actinomycosis of the lumbar vertebra. This began originally in the tonsil, travelled down the backed by a large scapular abscess, and finally involved the vertebra. At the necropsy some of the sections of the vertebræ were removed and given to Dr. Speese for examination. It was at first looked upon as tuberculosis with a mixed infection, but later developments in the skin showed the characteristic yellow-sulphur bodies, and the diagnosis of actinomycosis was confirmed at necropsy.

Dr. CHARLES H. FRAZIER reported a case of actinomycosis in a young man who had been referred to the University Hospital with the diagnosis of acute appendicitis. At the operation two unusual features were observed; a pin was found in the appendix and the whole right iliac fossa was a mass of adhesions and

exudate. The appendix was removed only after a tedious dissection and there was so much oozing that drainage was imperative. The drainage tract showed no signs of healing, but suppurated profusely and persistently. A few months later a metastatic abscess was found in the liver and drained, and upon curetting the pus from this collection Dr. B. A. Thomas discovered the actinomycosis. During the course of the next few months the patient developed two attacks of intestinal obstruction relieved by operation under spinal anaesthesia. Bacterin therapy, large doses of iodide of potash, and Röntgen rays were employed, but all to no effect. Neither the abscess in the right iliac fossa nor that in the liver showed any evidence of resolution. Finally the lungs became involved, and the patient died nine months after his admission to the hospital. There was no autopsy.

Dr. ASTLEY P. C. ASHHURST said there had been under his care in the dispensary of the Episcopal Hospital several years ago, a patient in which he made a tentative diagnosis of actinomycosis from the clinical findings. It was an early case, with not much induration. He sent the patient to the laboratory for an examination of the pus, and although the characteristic sulphur-like particles were found, no fungus could be demonstrated, and the pathologist came to the conclusion that it was a case of atypical multiple sebaceous cyst. Some months later in reading a German textbook on surgery he found the statement that sebaceous cysts in the face occasionally assume an actinomycotic appearance, and had been mistaken for this affection by others.

A STUDY OF ACTIVE IMMUNIZATION IN ANIMALS, PARTIALLY AND COMPLETELY THYROIDECTOMIZED

Dr. B. A. THOMAS (by invitation) and Dr. ROBERT H. IVY (by invitation) presented a paper with the above title.

PLASTIC RESTORATION OF LOWER LIP.

Dr. ADDINELL HEWSON presented illustrations from a case of epithelioma of the lower lip which was submitted to the use of arsenical paste in the hands of a charlatan. When seen by Dr. Hewson this lip was entirely destroyed, and metastases had taken place in both digastric and both superior carotid triangles, necessitating the removal of the alveolar process of the incisors,

canine and first premolar teeth with the involved periosteum on the facial surface of these alveoli and retaining the periosteum on the lingual surface of the alveoli, and finally the removal of four molar teeth and the closing of the wound by the Grant operation. Both facial arteries were ligated in the procedure, and the vestibular surface of the flap on the left side extended as far back as the entrance of Steno's duct. It is needless to say that this was done as a palliative measure and not with any idea of curing the patient, but to relieve the extensive slobbering which existed. The wound healed rapidly and the man's condition was improved. The use of X-ray, when it was found the recurrences had re-appeared in both sides of the neck, was not beneficial, as marked necrosis in the parts affected appeared.

MULTIPLE DIFFUSED METASTASES FOLLOWING BREAST CARCINOMA.

Dr. ADDINELL HEWSON read the history of a widow, sixty years of age, who was admitted to St. Timothy's Hospital, Jan. 12, 1909, on account of a tumor in her left breast. The patient presented the appearance of a fairly healthy woman with a mass 5 and 8.5 cm. in size, showing signs of skin involvement and about to ulcerate, in the cephalomedian quadrant of the left breast. The necrotic area measured 3 by 2.5 cm. The arteries and veins were prominent in the skin. A small nodule was felt in the left breast beyond the tumor towards the axilla over the course of the long thoracic artery. There was no supra-clavicular involvement; the nipple was retracted in the line of the cephalomedian quadrant, and the area towards the ventral axillary fold was flattened.

On Jan. 30, 1909, a Jabez Jackson operation was performed, removing the breast, both pectoral muscles, and cleaning out the axilla. The connection between the retraction of the nipple and the growth was shown in photograph of the gross specimen (Fig. 3) taken Jan. 31, 1909, immediately after removal. The wound was entirely healed on Feb. 19, 1909, and the patient was discharged to the dispensary for X-ray treatment. X-ray was applied tri-weekly until Oct. 8, 1909, in all seventy-three exposures, on which date the patient reported a small movable nodule about the size of a pea mezial to the mezial line of union, which was hard, movable, elevated, red but not sensitive; was slightly sen-

FIG. 3.



Carcinoma. Section at operation of breast (L).

FIG. 4.



Rib and femur. Longitudinal section.

sitive in the mezial and lateral lines of union. There were no axillary or supraclavicular enlargements palpable. On Oct. 18, 1909, this tumor was removed. On March 8, 1910, the patient, having had in the interval twenty-two X-ray treatments, reported that after a cold her right arm was swollen down to the wrist, and on examination exhibited a small moderately hard tumor about the size of a walnut in the right midaxillary region which was movable. Patient was advised to have this removed but begged off.

On March 11, 1910, an incision was made over this tumor and the mass enucleated together with the axillary fat, which was submitted to Dr. Swan, the pathologist, for macroscopic and microscopic examination. The diagnosis of soft carcinoma was returned and a Jabez Jackson operation was proceeded with cleaning out the intra-clavicular and axillary spaces. The wound was entirely healed and patient was discharged to the dispensary on April 14, 1910, up to which time the patient had had X-ray alternating each breast seventeen times.

On May 19, 1910, a small nodule showing a tendency to ulcerate at the right extremity of the second operation was noticed and also in the flap of the third operation, *i.e.*, right breast, there was an ulcer about the size of a lima bean with a hardened base but movable on the chest wall, but nevertheless nearer the median line than the ventral axillary fold. The patient was admitted at her request on May 23, 1910, and the fourth operation was performed which enucleated these recurrences.

On May 25, 1910, patient called attention to a hard tumor on dorsal surface of the alveolus of the left first bicuspid tooth. This tumor was fixed, slightly painful, but not inflamed. Patient stated that it had been there ever since the last breast had been removed.

In view of the frequent recurrences it was decided to try a carcinomatous vaccine as prepared by Dr. Coca at H. K. Mulford's laboratory. On May 29, 1910, 12 c.c. of a No. 30 stock solution was introduced into the cellular tissue of both recti abdomini muscles on a level with the umbilicus and over the right external oblique. Patient complained very slightly of pain. There were 24 c.c. in the injections used. On May 30 no complaint from the patient from the injections used. May 31, 1910, all stitches were removed and the wound found entirely healed.

There was, however, some slight induration in the cellular tissue over the right rectus muscle as a result of the injection used two days previous. There was nothing however palpable or visible of either of the other injected areas. Sterile dressings were applied over each; the patient was very sensitive about touching the parts and inclined to be fretful. She was discharged to the dispensary on June 9, 1910. Patient was readmitted to the house on June 23 on account of the extreme pain in the back and right side, which was worse on motion. She was given an antirheumatic and reported three days later as free from pain.

Patient was discharged to the dispensary on July 1, 1910.

July 7, 1910, patient reported as having a great deal of pain on the left side dorsally, pain extends to the left of the spine ventrad to the scapulæ and running around to the ventral aspect of the chest. On physical examination there was an area of dulness to the left of the thoracic spine running laterally 5 or 6 inches and starting about on a level with cephal margin of the scapulæ, continuing caudad for a distance of about 10 inches. In this area there was increased vocal resonance, increased tactile fremitus, and bronchial breathing; she was very nervous.

Patient was admitted to the house July 8, 1910.

Sept. 4, 1910, while the nurse was bathing her she noticed a swelling in the middle of the left femur. The leg gave the patient much pain on motion. On examination it was found that the femur was fractured and that there was overlapping with a shortening of $2\frac{1}{2}$ inches. The foot was considerably inverted. Buck's extension with 8 lbs. in weight was applied. This was later supplemented by a Physic splint.

Sept. 10, 1910, patient had been fairly comfortable and the extension had relaxed the tension of the muscle about the fracture, but in the meantime a bed-sore had appeared over the sacrum. Patient had involuntary discharges of urine and fæces.

Sept. 14, 1910: While changing the bed a deformity of the right femur was noticed, and upon investigating it was found that the right femur was spontaneously fractured 4 inches below (pedad) the trochanter. Patient was examined by three physicians and diagnosis confirmed. Patient gradually became weaker and died on Sept. 24, 1910, at 11.40 P.M.

Post-Mortem Report.—Both mammary glands have been removed, the operation having extended into each axilla. Over the sacrum was a large

excavating bed sore 20 cm. in diameter, with a thick, gangrenous, foul-smelling sloughing mass within it. The left femur was fractured about its middle. Right femur was fractured 4 inches below the greater trochanter. An incision was made on the external surface of the thigh through the intermuscular septum, the femur was sawed through above and below the fracture, and the specimen was removed—this on the left side. The specimen was cut longitudinally, and there was displayed a mass of tissue at the line of fracture about 3 cm. long and 2 cm. wide, the long diameter lying vertically (Fig. 4). There was some attempt at union in the fracture, there having been laid down scar tissue to such an extent as to mask crepitus. The marrow was red about 3 cm. either side of the line of fracture. Beyond this in either direction the color was normal. For about the same distance, either side of the fracture the medulla of the bone was rarefied. An incision was made through the right hip and the head of the femur was disjoined from the acetabulum. The upper portion of the bone was removed to within 4 inches below the line of fracture. At this point there was a deposition of new tissue, dense and white in character, invading the medulla and marrow cavity. This measured about 2 cm. in diameter. Here, likewise, the marrow was red either side of the fracture but beyond this was normal. Both axillae were opened. In the left was found a small flabby gland 1 cm. and 6 cm. thick. Nothing found in right axilla.

Liver: The common duct was patulous and no enlargement of the glands in this region or within the lesser sack of the peritoneum. The left lobe of the liver on its inferior surface was studded with white dense nodules varying in size from 2 to 8 mm. in diameter and sharply outlined, also slightly elevated. About 30 were present. On the superior surface of the left lobe were about 10 such nodules and about 6 on the spigelian lobe. Only 3 were seen on the inferior surface of the right lobe. About these nodules the liver substance was fatty degenerated, being yellowish in color. Aside from these last mentioned areas, general color of the organ was quite normal. On gross section only three small nodules were found within the right lobe, but the left and spigelian lobes were fairly well occupied by this new tissue. No enlargement of glands in the gastro-hepatic omentum or in the gastric splenic omentum. Stomach contained about 300 c.c. of brownish black material liquid in character. Very little post-mortem digestion had taken place in the mucosa. There was no evidence of old or recent ulceration. Stomach was dilated about one-half. Spleen was normal in size, slate gray in appearance, surface was shriveled, cut with increased resistance, scraped surface bled freely, and there was a slight excess of connective tissue in the trabeculae. No foreign growth present. Pancreas reached from the spleen well over into the curve of the second portion of the duodenum. It was quite normal in appearance, but felt slightly hardened.

Chest: Heart reached from the second to the fifth interspace in the midclavicular line. Lungs were darkly pigmented. Both lungs were adherent, apices both showed partial solidification, in this region and throughout the substance of each there were old dense calcareous nodules. In the

lower lobe of both lungs were several masses, which on pressure exuded from their cut surface caseated material. Specimens were taken from these areas.

Ribs and Vertebrae: The fifth, sixth, seventh and eighth ribs on the left side showed small masses or nodules about 4 mm. in diameter on their anterior surface immediately underneath the periosteum and about 10 cm. from the vertebra. The sixth and seventh ribs were fractured at about this distance from the vertebra. Some of these nodules were soft, and when cut exuded a white pus-like material, and in their neighborhood the rib could easily be cut through with a knife. On the right side the fifth, sixth, seventh, eighth, and ninth ribs had these nodules at about the same location as on the left and similar in size and consistency. Sixth, seventh, and eighth ribs were fractured. There were no masses in the intercostal spaces. Chiseling under the vertebra revealed no foreign growth.

A STUDY OF CARCINOMA MASTITOIDES.

Dr. EDWARD A. SCHUMANN (by invitation) read a paper with the above title, for which see page 69.

BOOK REVIEWS.

PRACTICE OF SURGERY, By JAMES GREGORY MUMFORD, M.D. Octavo, 1015 pages. Philadelphia, W. B. Saunders & Co., 1910.

This book departs from the ordinary methods of surgical textbooks. It is more a series of talks on surgery than an attempt to present in systematic and didactic way the facts of surgery. What the author has to say he has put in a direct personal form; he has a concise way of putting things, bringing to the front the more important matters, with a result that is clear and instructive, and that bespeaks experience and trained observation. There is a certain atmosphere of what might be called surgical common sense conspicuous throughout the book which is decidedly refreshing. No attempt to set forth what might be called the principles of surgery has been made; the writer begins at once with the individual surgical diseases, and in accordance with his plan to take them up in the order of their interest and importance and frequency, so as to preserve a certain surgical perspective, he begins with appendicitis, and goes on from this to a consideration in their sequence of other derangements within the abdomen. Indeed, the table of contents in this book is an interesting commentary upon surgical conditions at the present time. First part covers the abdomen; then the female organs of generation; third the genito-urinary organs, especially the male; then comes the chest, the face and neck, the head and spine; then a chapter on minor surgery, after which a certain series of diseases of structure are considered, including tumors and fractures and dislocations. It will be seen at once from the prominence given in this work to the female organs of generation that Dr. Mumford does not acknowledge that gynecology is not a part of general surgery.

It seems rather odd to a surgeon who was trained thirty or more years ago to read in a "Practice of Surgery" that, "It does not seem necessary to describe at length the various operations of perineal lithotomy" (page 404). This is precisely true, however, for it is an operation which has quite given way to the suprapubic approach in cases in which the removal by some crushing

process is not deemed best. There is no occasion to go into detailed examination of the various paragraphs of the book. From the text much is omitted which might have appeared. Its chief value is that it sets forth in so interesting a manner surgery as practised by Mumford himself. It is full of practical points, and no surgeon, whatever his experience, can turn its pages without finding something in it of practical value. LEWIS S. PILCHER.

THE DISEASES OF CHILDHOOD AND INFANCY. By HENRY KOPLIK, M.D., Attending Physician to the Mount Sinai Hospital. Third edition, revised and enlarged. Lea & Febiger, New York and Philadelphia. 1910.

The advance in the study of pediatrics during the past three years has been so marked that the author has found that not only was a revision of certain chapters necessary, but the introduction of entirely new matter was essential. The wide clinical experience of the author and the keen insight he has shown heretofore in the consideration of this subject are further demonstrated in this revision of his former work. The author has done all that was possible to make it thoroughly representative of the best and latest knowledge in its particular field. Some 200 pages have been added.

The keystone of any treatise of this class is naturally the problem of infant feeding. The mathematical basis which is used so widely at present is clearly and definitely set forth, and many indefinite points noted in this connection in the former edition have been made clear. We note that while the whey modifications are seemingly appreciated, exception may be taken to the difficulty mentioned by the author in its preparation, and its use is counselled against on this account.

The improvement in the chapters dealing with the diagnosis of the infectious diseases and the technic of their treatment is to be noted. Amplifications have been made to the sections considering diseases of the stomach and those of the nervous system, notably cerebral palsy, encephalitis, poliomyelitis, tetany, and amaurotic idiocy; revision of the chapters on cystitis and pyelitis has also been necessary.

New matter under the head of dwarfism and idiocy has been added. The superficiality of this consideration of infantile psychi-

atry shows the very meagre amount of knowledge we have on the subject, and hardly deserves a separate chapter as yet.

The descriptions of the various diseases and conditions are otherwise clear, definite, and complete, but not long enough to be tiring, and present a satisfactory résumé of the present day science and art of pediatry.

JAMES T. PILCHER.

THE SURGERY OF CHILDHOOD, INCLUDING ORTHOPÆDIC SURGERY.

By DEFORREST WILLARD, A.M., M.D. J. B. Lippincott Co., Philadelphia and London.

In these days of elaborate systems of surgery written by many authors, a treatise like the one before us, written by a single author, is of great value, as it represents the personal experience of many years of active surgical work. The record of the experience is especially valuable when we take into consideration the widely-known surgical qualifications of the author.

The first chapter of the work is directed to the general considerations of the surgery of childhood, which includes some important observations upon the anatomy of infants and children, and especially calls attention to the importance of a thorough and methodical examination of such patients, for the pediatric surgeon must necessarily depend largely upon objective symptoms in these cases upon which to base his conclusions.

The author next considers the various surgical diseases and injuries of infants and children occurring in different regions of the body, and among those especially to be commended is the article upon appendicitis, which he justly states is the most common and important surgical disease of the abdomen in children.

As might be expected from the author's extensive experience with orthopædic cases, the larger portion of the work is devoted to orthopædic surgery, and in the general consideration of this subject the qualifications of the orthopædic surgeon, the use and adjustment of mechanical apparatus and operative technic of this branch of surgery are fully described.

Tuberculous diseases of the bones and joints are fully considered; the comprehensive and practical character of the articles upon tuberculosis of the spine and tuberculosis of the hip-joint render them worthy of careful consideration. The author lays

great stress upon the open-air treatment of such cases, combined with operative and mechanical treatment.

The peculiarities of injuries of the bones and joints in infants and children and epiphyseal separations are fully described, and their diagnosis and treatment is carefully considered.

The chapters devoted to infectious arthritis, acute infectious osteomyelitis, and acute infectious epiphysitis of infants are especially worthy of careful study.

The articles upon tendon transplanting and nerve anastomosis represent the most modern teaching upon these subjects.

The reader cannot fail to be impressed with the very practical character of the article upon the etiology and treatment of the varieties of club-foot.

The work ends with an article upon congenital malformations of the joints and congenital deficiencies of the bones, and the author devotes considerable space to the consideration of congenital dislocations of the hip-joint. After describing the various methods of treatment for the relief of this condition, he states that in the majority of cases he prefers a method which has in his hands been followed by good results, viz., subcutaneous tenotomy of the abductors, the tensor vagina femoris, and the external iliofemoral fascia at the knee ten days before the reduction by the manipulations recommended by Lorenz is employed.

The work is well illustrated, the majority of the illustrations being original photographs. It is noticed that occasionally cuts of adults are introduced to illustrate certain subjects.

The work is eminently practical in character, and represents what is modern in pathology, diagnosis, and treatment, and can be recommended as a safe guide to the surgery of childhood.

HENRY R. WHARTON.

AN ANATOMICAL AND SURGICAL STUDY OF FRACTURES OF THE LOWER END OF THE HUMERUS. By ASTLEY PASTON COOPER ASHHURST, A.B., M.D. Philadelphia, Lea and Febiger, 1910.

This is the Samuel D. Gross prize essay of the Philadelphia Academy of Surgery. The trustees of the Gross fund may feel that they have bestowed the prize for 1910 upon an essay of merit. It has the advantage of dealing with a practical every-day ques-

tion. Most of the patients observed were in the author's services at the Episcopal and the Children's hospitals.

In opening the subject, some of the current teaching is quoted to show the bad prognosis commonly given in elbow fractures. Most of the text-books, the author says, give an unfavorable prognosis, and the quotations from these seem rather more doleful than the common experience in competent hands would warrant. The author is not speaking for himself alone but for modern surgery in general when he says, "With common-sense surgical treatment, the prognosis of any and all fractures involving lower end of the humerus is much less gloomy than it has heretofore been considered, and that in the vast majority of cases the ultimate results will be perfectly satisfactory."

In the author's experience the frequency of fractures is in the following order: Supracondylar, 29; external condyle, 12; epiphyseal separation, 7; internal condyle, 4; epitrochlea, 3; intercondylar, 1. Emphasis is laid upon the fact that, if no portion of the diaphysis is detached, in epiphyseal separation, the line of separation passes directly along the epiphyseal line, and hence will not be visible in a skiagraph.

The most satisfactory chapter is that on the general mechanism by which fractures of the lower end of the humerus are produced. This is a subject not given sufficient attention by teachers and text-books. The rules for examining the patient are admirable. "It is always well to go from the known to the unknown; it is frequently useless to begin by palpating bony prominences around the elbow, since from the extent of the swelling it may be impossible to identify them in this way. Unless some definite method is followed, some important point is nearly sure to be overlooked." Also in the interpretation of radiographs the author displays a large grasp of the subject.

The study of the individual cases is instructive. The treatment is fully described for each form of fracture. Hyperflexion is the position employed by the author in the permanent fixation in all of the fractures described in this book. He recommends hyperflexion warmly for all fractures except the intercondyloid variety.

This method of treatment has been given a pretty thorough test in the hands of many surgeons. It is the feeling of the reviewer that Dr. Ashhurst has permitted his enthusiasm for

hyperflexion to carry him far. Most cases are best treated by this method, but cases are met in which it is distinctly not applicable. The reviewer has seen such cases. Dr. Ashhurst shows such in this book. Case 24 is distinctly such a one. It should not have been put up in extreme flexion. Case 28 is another in which a better result would have been secured, most probably, by other measures.

Studies of series of cases, such as this, with minuteness, constitute the most valuable sort of surgical literature. Dr. Ashhurst has performed a distinct service. J. P. WARBASSE.

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